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An Investigation of the Drought Pastures of the Murchison District of Western Australia.

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INTRODUCTION.

THE need for a better understanding of the scientific principles underlying pastoral management and animal husbandry in the arid to semi-arid pastoral areas of Australia, has long been felt, but not until recent years has any marked progress been made in this direction.

With the inauguration of the arid research station at Koonamore, South Australia, a definite step towards a systematised study of problems connected with arid vegetation and its relation to the grazing animal, was taken.

Previous to this such workers as Cannon (1), Adamson and Osborn (2) and Osborn (4) and Wood (3) had made a study of the subject mainly however from a botanical point of view. Looking further afield to South Africa with somewhat similar problems to our own, we find considerable amount of energy and money expended in the elucidation of problems peculiar to an arid region of pastoral production. Western Australia, possessing as it does some 486 thousand square miles of country that can be classed as arid, presents a problem unique in this regard. Almost 50 per cent. of the State receives a rainfall of less than 10 inches a year which area is confined solely to pastoral pursuits. The great area of pastoral country together with the remarkable diversity of soil and vegetation types opens up a particularly extensive field for investigation.

No apology therefore need be made in presenting an account of investigations which at this stage have been essentially preliminary in nature, and confined to one particular region of pastoral activity.

GENERAL INTRODUCTION ON THE MURCHISON COUNTRY.

The Murchison district of Western Australia, so named after the river which traverses its Western portion, comprises a large triangular shaped area the apex of which cuts the coastline at Shark Bay. This belt broadens as its passes inland in a W. to S.W. direction until it merges into the North-Eastern Goldfields. The district is included in the extensive Acacia formation which extends, as a belt of some 200-300 miles wide, from the Western coast at lat. 24 deg. S. in a S.W. direction to the South Australian border. The Southern boundary coinciding fairly closely with the 10 inch winter isohyet is clearly defined by change in vegetation from Eucalypt to Acacia formation. To the North the Murchison country passes more gradually into the Gascoyne.

Mulga (*Acacia aneura*) lopped for sheep feed during drought.

The value of this area as pastoral country was not realised until about the 70's of last century when small flocks of Merino sheep were introduced.

The definitely arid nature of the climate of the area had previous to that time proved a deterrent to settlers, but with the realisation of the exceptional wool growing capacity of the natural vegetation together with the discovery of good water at shallow depths, the future of the area for pastoral production was assured. Water supply to stock even in the severest of droughts has never been a serious problem.

Wells were sunk by the pioneers in creek beds where water was usually to be found within 10 feet of the surface. These wells, circular in shape, still remain as relics of pioneering days. They provided water for stock and man after natural pools had dried out. The general practice was to shepherd the stock from pool to pool or well to well using aboriginal labour.

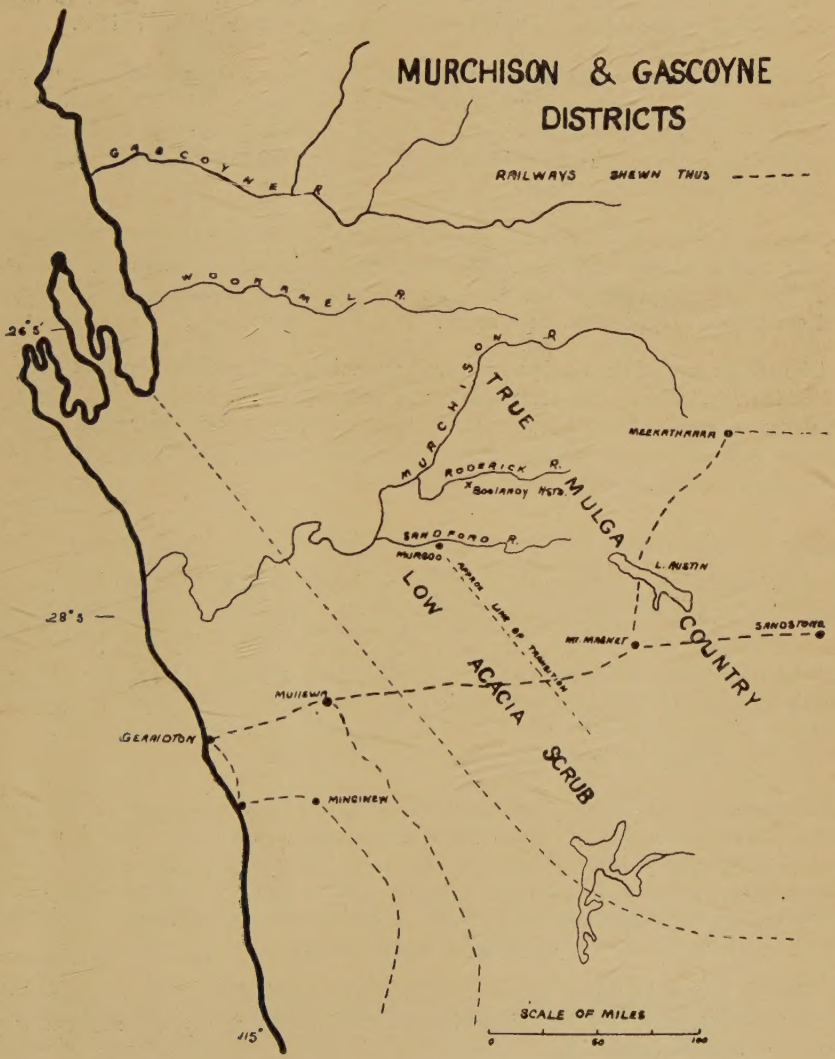
The task of baling the water with rope and bucket was particularly arduous, limiting the size of the flocks to comparatively small numbers. Under this system only a very minor portion of the grazing was utilised, the amount being largely determined by the frequency and location of the pools and wells. That portion of

the country which was utilised was intensely overstocked, which was reflected in the deteriorating vegetation. Evidence of this continual shepherding over confined areas are still to be seen, being marked by tracts of country almost denuded of vegetation.

It was not until the introduction of well-fenced paddocks supplied with watering facilities, that the carrying capacity of the grazing was substantially increased.

The Murchison is singularly fortunate in its water supplies. Good stock water can be obtained almost anywhere in the region from 50-100 feet of the surface. In the Mulga thickets renowned for their excellent drinking water, supplies can be obtained at shallower depths.

Saline waters do occur, especially in the open saltbush country; they are however, quite palatable to sheep.



Geography and Topography.

The monotonous flatness of the country is a feature of the Murchison, or at least that portion West of the Wiluna railway. Except for isolated mesas and buttes which stand out as relics of the old plateaux, and occasional granite outcrops, the country presents a vast level plain blanketed by a covering of low Acacia shrubs and trees. The intense flatness is particularly noticeable in the portion North of the Sandford River. To the South of this river the country becomes increasingly undulating in character passing into the sand heaths of the Northern wheatbelt.

Traversing this region is the Murchison river system including its two tributaries, the Roderick and Sandford Rivers, all of which are intermittent in character —only flowing to any extent after heavy falls of rain. After such rains these rivers become raging torrents flooding the country for miles on either side of their course

The soils of the region are almost universally clay loams of a red to brown colour overlying a hard siliceous hardpan impregnated with red iron oxides.

Teakle (5) proposes that these hardpan soils should be designated as a new soil type and proposes the name of "red and brown hardpan soil." The hardpan lies usually within 6-12 inches of the surface except in depressions where soil accumulation has taken place. The hardpan itself varies greatly in thickness from a few feet up to a hundred feet or more.

From soil profiles exposed on river banks the definitely laminated structure of the pan is shown, also the calcareous intrusions of "opaline" material. In some areas these calcareous deposits outcrop in either isolated patches or belts carrying plant communities typical of such areas.

The occurrence of the hardpan naturally restricts and modifies the root development of the vegetation. A consequence of the presence of the hardpan in the general lateral development of the plant roots. There is however in the mulga quite an extensive development of the tap root which manages even in the very young stages of the plant to penetrate the cracks in the hardpan.

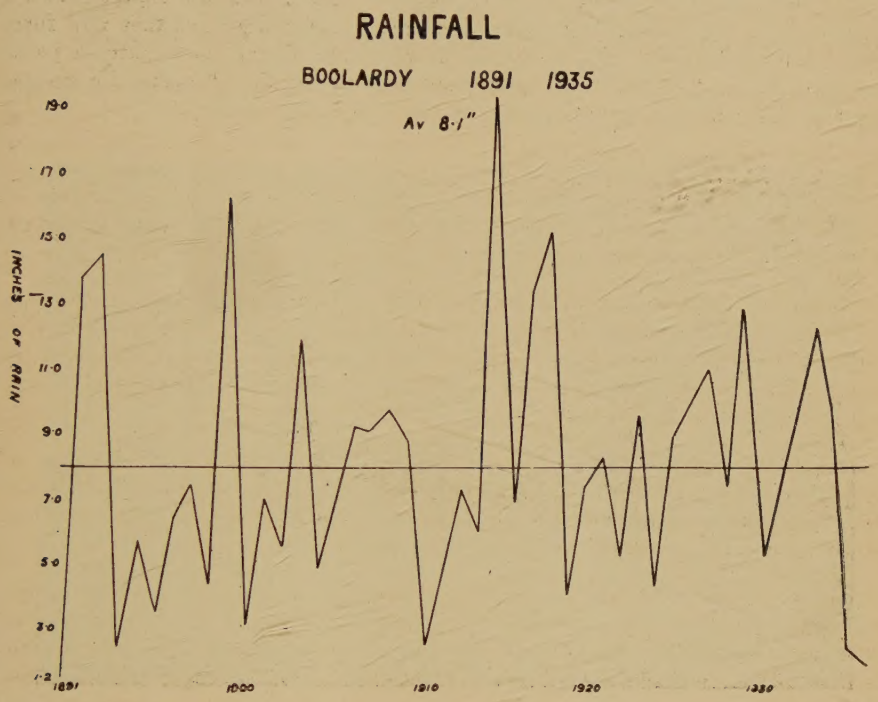
Rainfall.

The rainfall of the Murchison is characterised by its highly intermittent character. Not only is the annual average less than 10 inches but the incidence of the rain is extremely erratic. To give some idea of the differences from year to year in the annual totals some figures from the Boolardy records are given. Boolardy Homestead is situated on the Roderick River and receives equal summer and winter rainfall. The maximum annual total for this station during the last 45 years is 19.4 inches, whereas the minimum is as low as 1.2 inches.

From this it can be seen that the average figure for the 45 years of 8.1 inches gives little indication of the effectiveness of the rain. Generally years of drought are followed by plentiful rains which have the effect of restoring the annual average. Intense drought such as has been experienced during 1935-36 is fortunately of rare occurrence but lesser droughts and "light" years are only too common. The highly xerophytic character of the vegetation bears this out.

The accompanying chart illustrates the great variation from year to year in the annual rainfall, also the fact that three out of every five years are below the yearly average of 8.1 inches.

A point to be recognised is the large number of small ineffective falls which have little or no effect upon the vegetation. A fall of 50 points, if not followed within a day or two by further rain, is almost useless. The large numbers of such falls during certain years are liable to give rise to a misinterpretation of the effectiveness of the yearly total.



Vegetation.

The vegetation of the Murchison district is composed almost entirely of Acacia species being termed generally as "Acacia Semi-desert Scrub." The Eucalypts, so frequently met with further South within the 10 inches isobyst, are here confined entirely to the more favourable spots along creeks and rivers.

Within the Acacia formation two definite types of country can be recognised:

1. The Southern portion extending from the Eucalypt formation Northwards to the Sandford River.
2. The Northern portion extending Northwards from the Sandford.

1. In the Southern region the undulating country is covered by an exceedingly dense growth of shrubs which rarely exceed 8-10 feet in height. The density of the vegetation is a striking feature of this Southern region. The true mulga of the North with its tree-like form is absent. Rainfall in this region is mostly of winter incidence and summer rains, when they do occur, do not produce a dynamic effect on the vegetation as they do in the Northern areas.

The most common shrubs of this area are the Snakewood (*Acacia eremaea*), Minerichi (*Acacia grasbyi*), Jam (*Acacia burkittii*), Curara (*Acacia tetragonophylla*), the Black Wattle (*Acacia sclerosperma*) and Sugar Brother (*Acacia*

brachystachya). Within ten miles of the Sandford River the transition in the vegetation appears to take place. The jam tree and wattles which were previously so abundant become more and more confined to the watercourses whilst the tree-like forms of true mulga take their place. A transitional belt extends roughly from the Sandford to the Roderick River.

2. North of the Roderick River the vegetation takes on a new aspect entirely. Whereas in the transitional belt mulgas occurred in isolated groups they now form definite belts and thickets and dominate the vegetation giving the country a park-land appearance. The density of the vegetation of the South is forsaken for greater height of the individual shrubs typical of the true mulga country.

Mulga country after regeneration.

The importance of differentiating between these two types of country cannot be overstressed as the pastoral problems of the two areas, depending as they do chiefly on the type of vegetation, are in no way comparable to one another.

Pastoral Development.

Due to the irregularity of rainfall, agricultural pursuits are non-existent in the Acacia formation. The area is solely devoted to pastoral activity, which is based on the natural grazings (mostly top-feeds).

The region forms one of the most important sections of the State's wool producing areas. Some three million sheep are carried, production being confined to wool except for the yearly culls which are sold at the nearest rail head. Heavy culling in good seasons is practised by most pastoralists who aim at producing good constitution sheep able to withstand the lean drought years.

The pastoral holdings, held on lease from the Crown, and known as Stations, comprise areas ranging from 200,000 acres to one million acres, divided into paddocks of 10-30 square miles or even larger.

The paddocks are in most cases well watered, few points being more than three to four miles from a drinking trough. Windmills supply the power to pump the water from comparatively shallow depths into storage tanks, from whence the water gravitates to the troughing system.

This equipment requires constant attention during the dry season whilst the stock are solely dependent on the mills for their water requirements. During the good season creeks and surface pools relieve the mills. Visits are made at least twice weekly to each windmill when troughs are cleaned and working parts of the equipment tended.

Mulga country after rain showing ephemeral growth of *Trichinium alopecuroideum*.

The stock are allowed a very wide range of country, 20 acres to the sheep being regarded as the stocking capacity. During drought periods one sheep to 50 or 100 acres is perhaps the total capacity of the country.

The feeding habits of the sheep largely depend on the season. During the good season when grass and herbage are plentiful the sheep show their gregarious tendency and travel in flocks, but during the dry periods when feed is scarce, top-feeds providing the sole picking, groups of two or three or quite often solitary sheep are seen. Seldom does one see groups of more than six or eight.

The amount and quality of the top-feeds are the limiting factors controlling the productive capacity of this region. The ephemeral growth while providing a flush of feed, is very spasmodic in its appearance.

ECOLOGICAL SURVEY OF AN AREA ON THE RODERICK RIVER.

When the investigation was initiated it was decided that a specialised survey of a typical section of the country should be made to give some idea of the type of vegetation occurring; also information relating to its frequency, distribution, relation to topography, edibility, accessibility and general pastoral utility. The desir-

ability of having such an area for future reference was also considered. The survey was carried out during the depths of a drought when the more resistant perennials constituted the entire vegetation.

For various reasons it was thought desirable to conduct the survey in the vicinity of the Boolardy homestead, and after preliminary observations an area, intersected by the Roderick River and comprising several small paddocks, was selected as most representative of the vegetation types found on the station. The area was particularly suitable in illustrating the transition from arid shrub steppe open country into the mulga thickets of the flood plain which constitute the two main types of country in that part of the Murchison.

Windswept flats showing denuded bushes of Curara and Kochia spp.

Methods of Investigation.

The area was traversed by running a series of transect lines with the aid of a prismatic compass, at intervals of some 200 yards, using the fences as reference points. Distances were measured by pacing.

All plants occurring with 2-3 yards either side of the transect were noted, together with particulars as to height, edibility, etc.

Changes in soil character and topography were extremely gradual throughout the area, but where such changes were sufficiently marked to be observed, they were noted.

From this data the vegetation map included with the text was compiled, giving the extent of the more important plant associations. Reference will be made to this map (see page 12) in the description of the vegetation of the surveyed area.

Topography.

The general fall of the country, as can be seen from the course of the rivers and various creeks, is in a South-West direction. There is also a slight fall to the North-Western corner. To the South the area passes into a flood plain bearing typical mulga thickets.

Two main regions may therefore be distinguished—

1. The higher open country of the Northern portion (including almost the whole the Stud Ewe paddock).

2. The lower flood plain of the South (including Orlbinger and Nungully paddocks).

1. *The Higher Open Country of the Northern Portion.*

In the higher country the relationship between topography and vegetation is most marked. On the rises where the soil layer is generally thin the vegetation is spare. Mulga only occurs in the most favourable positions such as the headwaters of creeks and small depressions where accumulation of soil has taken place.

Mulga regeneration.

The higher country may be subdivided into four main habitats, each bearing a typical plant association.

(a) *The General Plain*—Shown on the map as a broad belt following the course of the Roderick River. The general impression of this habitat is an expanse of perfectly level country covered by a mantle of varying density of low shrubs or herbs growing little more than two feet in height. *Kochia, Atriplex* and *Rhagodia* species are the most common plants, the former predominating. The *Kochia* spp. produce robust bushes, whilst the *Atriplex* spp. with their slender stems of trailing habit appear to be much more readily eaten out. It is possible that the preponderance of *Kochia* spp. is the result of stocking Flannel bush (*Solanum ellipticum*) together with odd clumps of Fuchsia bush (*Eremophila maculata*) and Cotton bush (*Trichinium obovatum*) also make an appearance. All three of these bushes are particularly edible and drought resistant.

Various species of Cassia chiefly *C. eremophila, C. desolata* and *C. Sturtii* which are to be found quite abundantly in most of the drier habitats, find a place amongst the "salt" bushes. The Cassias generally are inedible and except for the seeds, they produce little of value as stock feed.

Dotted about the plain are plants of more mesophytic character which have apparently survived in a spot where water relations are more favourable. Isolated mulgas of a variety typical of this habitat together with Black Wattles and Acacia victoriae (known by the natives as Wallibudda) find such spots suited to their requirements.

The mulga of this region is a low-growing rather stunted tree bearing terete or very slightly flattened phyllodia which are very edible to stock, as evidenced by the way these trees are eaten up as far as the stock can reach.

The Black Wattle (*Acacia sclerosperma*) which at all times appears green and fresh is almost always associated with limestone outcrops. Their bright green colour, isolated in surroundings of dull greys, forms a striking contrast to the rest of the association.

Although the drainage of the surrounding country is generally well defined, there are relatively small basins on the plain that appear to have inadequate drainage. In such depressions the water lies till it evaporates leaving an accumulation of salts on the hardpan formation. To the South of the Roderick River on the saltbush plain these hardpans are particularly numerous. Surrounding these bare pans the sage bush (*Kochia* spp.) is particularly abundant. Other depressions occur on the plain, but unlike the former they carry abundant vegetation, appearing as oases in a "desert" of saltbush. Here Curaras (*Acacia tetragonophylla*) and Mulgas (*Acacia ramulosa* and *Acacia aciphylla*) predominate, with Needlewood (*Acacia cyperophylla*), currant bush (*Scaevola spinescens*) and other shrubs, more often associated with more favourable habitats, which find such patches suited to their growth requirements.

Apparently in these depressions subterranean drainage precludes clay pan formation. Soil accumulates due to water and wind action, and is bound together by the roots of the plants, forming a reservoir for the reception and storage of water. Rain falling in surrounding areas is concentrated by run off into such patches; thus only a few points are sufficient to cause the inhabitants of these "oases" to burst into new life producing flowers and foliage whilst the surrounding vegetation remains in its dormancy.

A plant outstanding for its extreme drought resistance and value as a stock feed is the "Currant bush" or Box (*Scævola spinescens*) which occurs in this habitat. It withstands drought and heavy stocking extremely well, remaining green and succulent throughout the driest periods.

The Wallibudda (*Acacia victoriae*), or as it is popularly called by pastoralists the "Acacia," is another bush which deserves mention. It appears to favour limestone patches, occurring in clumps or as isolated bushes throughout the habitat. There appear to be several closely allied species varying in edibility.

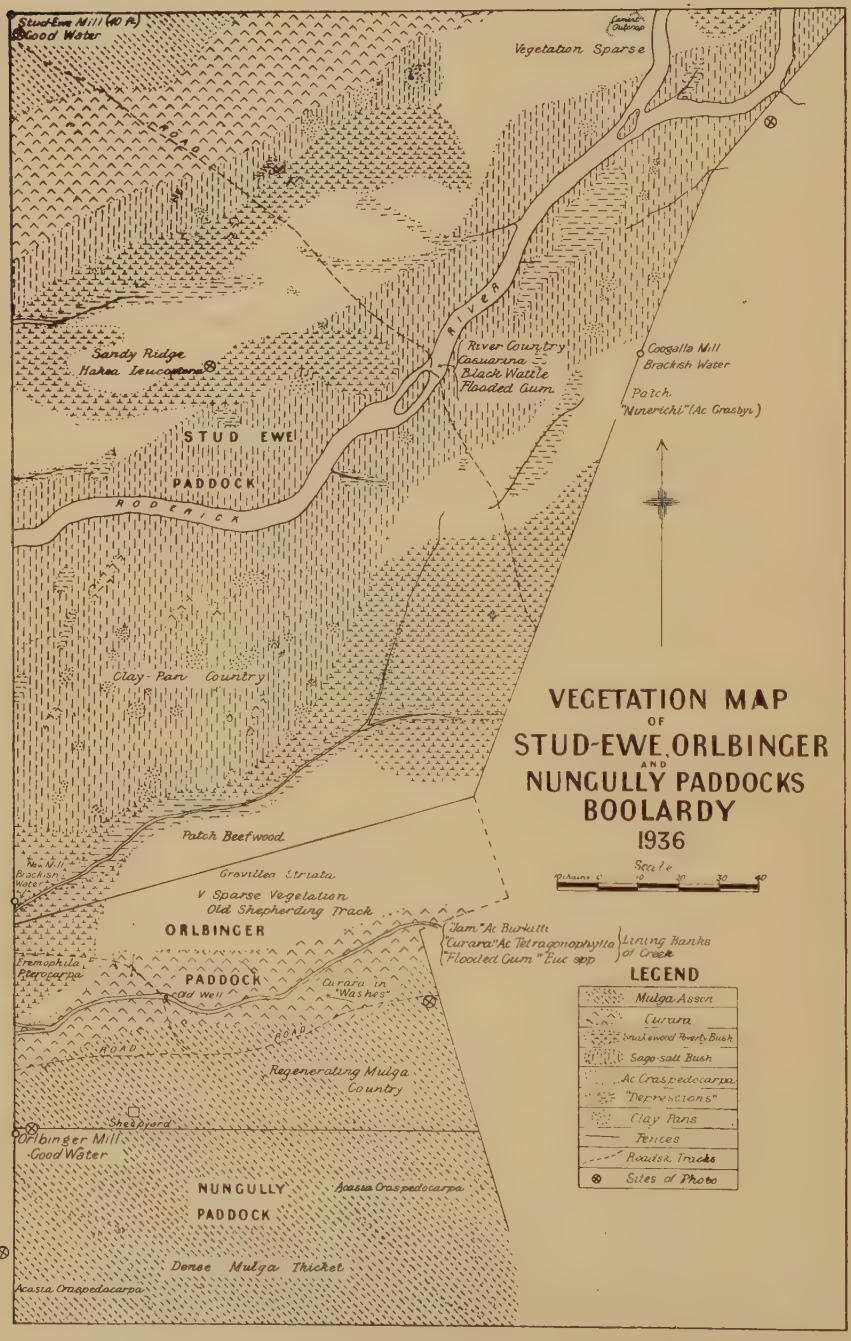
As with quite a number of the bushes of this association the feeding habits of the sheep with respect to the "Acacia" bush are rather spasmodic. There appear to be certain times at which the sheep relish them and others when they do not touch them.

The association of the plain consisting as it does of low growing bushes of high edibility and frequent occurrence, provides a great amount of feed, and possesses probably the highest stocking capacity of the various plant associations. During the drought however, the whole plain has been practically defoliated making it extremely difficult to distinguish between the species. With the lightest falls of rain however, this association responds to a remarkable degree providing quite good picking for some weeks.

(b) *Higher Country*—Occurs extensively in the Stud Ewe paddock to the North and South of the saltbush belt.

On passing from the plain to the higher country (there is actually little in altitude) the vegetation changes in composition, becoming sparser with little or no undergrowth. The habitat carries a plant association of the most xerophytic character. The Snakewood (*Acacia eremacea*) known by the natives as Bilya, together with Poverty bush (*Eremophila pterocarpa*) are the predominating shrubs. The soil layer is very shallow and the edaphic conditions generally are such that this habitat capable of supporting only the most xerophytic species. On the fringe of the association the Fuchsia bush (*Eremophila maculata*) and Cotton bush (*Trichinium obovatum*) form a sparse ground covering. But as one proceeds into the association the undergrowth disappears leaving the ground extremely bare in between the Snakewood and Poverty bushes. The Fuchsia bush mentioned above has been named as a poison plant, but in the region under discussion the bush was extremely well eaten. Whether it had any deleterious effect on the stock is not known.

The Snakewood grows to a shrub of some 10-12 feet in height, producing a dense canopy of broadly lanceolate *phyllodia,* which are held vertically by the numerous small branches arising from a short main trunk. The *phyllodia* are very fibrous and almost totally inedible and practically inaccessible, but the pods when produced are sought after by stock. The Snakewood is not confined to this habitat and may be found occurring extensively in the lower lying areas surrounding clay pans. In general it may be said that the Snakewood occurs in those habitats least favourable to the growth of more xerophytic plants such as mulga.


Stud-Ewe Mill (40 ft.)
Good Water
Vegetation Sparse
ROAD
RIVER
Sandy Ridge
Hakea Leucoptera
River Country
Casuarina
Black Wattle
Flooded Gum
Coogalla Mill
Brackish Water
Patch
"Minerichi" (Ac. Grasbyi.)
STUD EWE
PADDOCK
RODEJACK
Clay-Pan Country
VEGETATION MAP
OF
STUD-EWE, ORLBINGER
AND
NUNGULLY PADDOCKS
BOOLARDY
1936
Scale
Patch Beefwood
Grevillea Striata
Mill
Brackish Water
V Sparse Vegetation
Old Shepherding Track
ORLBINGER
Jam "Ac Burkitti
Curara "Ac Tetragonophylla
Flooded Gum "Euc spp
Lining Banks of Creek
Tremophila Pterocarpa
PADDOCK
and well
Curara in "Washes"
ROAD
Regenerating Mulga Country
Shed
Orbinger Mill
Good Water
NUNGULLY
PADDOCK
Acacia Craspedocarpa
Dense Mulga Thicket
Acacia Craspedocarpa
LEGEND
Mulga Assen
Curara
Saltbush Poverty Bush
Sago-salt Bush
Ac Craspedocarpa
"Depressions"
Clay Pans
Fences
Roads, Tracks
Sites of Photos

The Poverty bush (*Eremophila pterocarpa*) forms the major part of the association occurring more widely and frequently than its associate. Its xerophytism is even more marked than in the case of the Snakewood. Of a more bushy habit, it seldom exceeds 6-8 feet in height producing a mass of small, dull green succulent leaves. Due to their very strong taste and odour, however, they are not eaten except in the deepest drought.

During this year the stock have seemed to take to this bush apparently having acquired a taste for it in the absence of better feed. During drought it is one of the very few shrubs within reach of stock which still bears foliage.

Considering the wide distribution of the Poverty bush, its great drought resistance and the fact that stock will eat it during the dry times, it appears quite likely that its value as a stock fodder has been underestimated. As on the plain, patches of Curara and mulga of very limited extent do occur in favourable patches where the soil is deepest.

(c) *The River Country*—In the area under discussion the course of the river is extremely well defined by banks dropping almost vertically from the level of the plain. The course of the river is marked by a green riband of vegetation some hundred yards wide which contains a number of genera restricted to this habitat. Perhaps the most prominent tree is the *Casuarina* which forms dense thickets following the bed of the river. It attains a height of some 20 or more feet producing a dense mass of dark green foliage which is quite edible but is largely inaccessible. Towards the banks the Black Wattle predominates with a few Flooded Gums producing their ghostly white trunks. The Black Wattle is particularly well eaten by stock. Of the halophytic species of plants the Samphire and Saltbush (chiefly *Atriplex rhagodioides*) predominate and form a band lining the salt encrusted river bed. This belt is succeeded by the Black Wattle and Eucalypts which extend to the level of the plain. Other genera of less importance find this habitat favourable to their growth. These include several Grevillea species, Cassias including the edible *Cassia chatelainiana, Scævola* spp. and *Eremophila pantoni,* a so-called Poverty bush occurring quite frequently on limestone ridges. Its beautiful blue flowers are a source of admiration. A conspicuous absentee from this habitat is the mulga which is singularly intolerant to salty localities.

The value of the river country during drought, notwithstanding its very limited area, must be appreciable considering the density and fairly high edibility of the vegetation it carries.

(d) *The Smaller Streams and Washes*—The drainage channels and "washes" are particularly well marked by the way in which the vegetation is clustered about their margins forming belts of vegetation which stand out prominently from the surrounding country. Particularly is this so on the saltbush plains where the drainage channels are clearly defined by the belt of Curaras and mulgas associated with them.

In these watercourses soil accumulates and is bound together by roots and refuse from the trees. The water-retaining power is increased, making such localities favourable habitats for the growth of denser

vegetation. On reviewing these streams from their source up to the point at which they join the river one is particularly struck by the succession of plant species.

At the source of the stream where the water of the catchment area is concentrated to form a definite depression the mulgas of various species predominate. Further down the stream at a point where a definite channel is distinguishable the Curaras (*Acacia tetragonophylla*) begin to take the place of the mulga until a point is reached at which the mulga disappears and the Flooded Gum takes its place as an associate of the Curara. As the channel continues to become better defined the vegetation as well as changing in character, also changes in intensity being restricted to the banks lining the channel. From this point until the stream enters the river the vegetation increasingly resembles the typical river vegetation described above. It appears possible that this succession of species is related to the increasing salinity of the water. This phenomenon is most obvious in the streams flowing through saltbush country. In the streams flowing through mulga country the "Jam" (*Acacia burkittii*) Curara, and scattered mulgas are the chief vegetative types occurring along their banks.

Sheep feeding on lopped Mulga.

2. *The Lower Flood Plain of the South.*

This habitat is the home of the Mulga, where it occurs in dense thickets almost to the exclusion of other species. The fringe of such an association is shown in the Southern-most portion of the map.

The line of demarkation from the open country to the flooded areas is most marked. One is first struck with the increased density of the vegetation, the greater proportion of which attains tree-like proportions in the latter habitat. Several factors related to the topography have the effect of making this habitat a favourable situation for the growth of the more xerophytic plants. The water relations of the

lower lying land are more favourable due to run off from the surrounding country. Also due to the greater depth of soil the water retaining power of the area is greater. These factors have a marked effect on the resulting vegetation.

The Curara (*Acacia tetragonophylla*) grows to a larger size in this habitat and is particularly abundant, lining the washes and small water courses where the water relations are most favourable. The bushes are of spreading habit attaining some 10-12 feet in height and covering the ground for more than 10 feet around the trunk with their trailing stems, carrying the small spiny phyllodes so relished by stock.

This bush, due to its occurrence in practically all plant associations of the area, together with its high edibility, is quite the most important fodder plant on the Murchison. Unlike most of the plants of this region the production of resinous secretions and protective hairs is negligible; its response to drought conditions being the loss of its phyllodia.

Sheep feeding.

Its value as a stock feed during the most critical periods is therefore greatly reduced. However, with the smallest falls of rain the apparently dead bushes burst into life, providing valuable feed at a time when most needed.

A belt of Curara is shown occurring in the North-West corner of the map. This belt marks the termination of a creek which at this point loses its identity and spreads its waters over the flood plain. The general vegetation of the flood plain is however Mulga, which in this habitat attains its greatest development. The uniform size of the trees together with their regular spacing gives one an impression of an orchard; this impression is further enhanced by the regular canopy-form of the tree tops.

In the denser thickets the Mulga precludes competition from the other shrubs, occurring as pure communities. In the clearings between the thickets species of Cassia and *Eremophila* (chiefly *E. Fraseri* and *E. Leucophylla*) together with Curara (*Acacia tetragonophylla*), Currant bush (*Scaevola spinescens*), Sandalwood and other minor shrubs find a place suitable to their growth.

A shrub which deserves mention here is the so-called "Poverty bush" (*Eremophila leucaphylla*) which occurs in most habitats but perhaps most profusely in association with the Mulga. The bush is of low-growing habit, rarely exceeding five feet in height and bears excessively hairy leaves which give the plant a felty appearance. Unlike most of the *Eremophila* species the production of "lacquer" is negligible, there apparently being an exchange with loss of secretion and formation of the felty covering.

Opinions regarding its edibility vary, but from observations it appears to be quite palatable to sheep. It is extremely drought resistant and with the first rains produces a wealth of succulent shoots which are relished by stock. From chemical analysis the feeding value is particularly high especially with regard to the protein fraction (15 per cent.).

Taking the association as a whole its stocking capacity is low. The dominant constituent, the Mulga, is almost entirely inaccessible and contributes very little in the way of stock feed except for fallen leaves and pods.

Unless this vast supply of topfeed is made available by lopping or cutting its pastoral value must of necessity be low. The value of this natually conserved fodder for use in times of drought is a point which is not generally recognised. Regarded as a standby fodder the value of the Mulga to the pastoralist is inestimable.

A frequent inhabitant of the flood plain is the *Acacia craspedocarpa* known by the natives as Thadangu. It occurs in thickets in almost pure communities. Such a thicket is shown occurring in Nungully paddock in the Southern most portion of the map.

The phyllodia of this shrub are broad, very thick and fleshy, and are produced very abundantly giving the bush a density of foliage rarely found in this region. When in flower the shrub presents a most beautiful sight with its abundant clusters of bright yellow wattle blossoms. The pods which are broad and long, some being as much as three inches in length, are sought after by natives and stock for the seeds they contain.

The spreading habit of the shrub, which often attains 15 feet in height, precludes the existence of any undergrowth. In a good season, after March or April rains, ephermeral growth consisting chiefly of Mulla mulla (*Trichinium* spp.) covers the ground providing a wealth of feed. It is in such country that in past years some of the feed has been cut for hay. The impossibility of using a machine for the purpose, and the labour required for cutting any quantity with a sickle, has deterred the pastoralist from any extensive scheme of hay cutting.

The Thadangu itself is, except for its seeds, practically useless as a stock feed, due to its almost total inedibility. Even in the worst droughts the stock do not seem to touch it.

A shrub which does not really belong to the flood plain but which is found in locations on the fringe of the Mulga thickets is the Minerichi or Redwood (*Acacia grasbyi*). This shrub, growing to 10 to 12 feet in height is particularly easy to recognise by its red scaly bark which peculiarly enough is eaten by horses. The wood is very heavy and burns well even in the green state.

The Minerichi occurs more frequently in the South Murchison where it forms large communities, while in the true Mulga country its occurrence is generally

sparse. The bush is not very edible, nor is it particularly accessible. The phyllodia are very hard and fibrous and some pastoralists hold the opinion that it causes digestive troubles in stock.

A belt of vegetation consisting chiefly of this shrub commences just South of the Coogalla mill and extends in an Easterly direction before passing into sparse Mulga.

Association of Bowgada (*Ac. linophylla*) and grasses Eriachne spp. on Wandarrie country.

An association which was not included in the area surveyed but which deserves attention here, seeing that it occurs quite frequently on the Murchison, is that of the Bowgada bush or Wandarrie. Such "Wandarrie" patches, as they are called are associated with a definite soil type, which is of a rather loose texture composed of large particles or grains; the soil has a general appearance of immaturity. The soil layer is deeper than in other habitats and for this reason such areas are often chosen by pastoralists for homesteads and garden sites.

The Bowgada (*Acacia linophylla*) is easily recognised by its peculiar globular shape and its fine terete phyllodia. The pods also, are very characteristic resembling lead pencils in form. The seeds they contain are readily sought after by sheep.

Associated with the Bowgada is a perennial tussocky grass (Wandarrie grass) *Eriachne* spp., which was seen to occur only in this habitat.

The Wandarrie country appears particularly suited to the growth of perennial grasses.

A peculiarity about the association of the grass and the Bowgada is that they do not occur intermingled one with the other as may be expected, but the grass occurs as a definite patch or belt surrounded by or bordering the belt of Bowgada.

Opinions regarding the edibility of this Acacia appear to differ widely from station to station, but from observations on Boolardy it would seem that the edibilty is decidedly low. Being comparatively low-growing in habit of growth the lower

branches of the shrub are quite accessible to stock, but only in isolated places have been seen to be eaten. When forced on to it, as when confined to holding paddocks during shearing, sheep will eat it.

4.—FIELD STUDIES IN MULGA.

The term "Mulga" is generally applied to describe the Acacia formation which extends in a rough East-West direction dividing the Northen summer rainfall areas of the State from the winter rainfall areas of the South.

Gardner and Kessell (6) show the formation as extending from North of the Nullarbor plain in a rough North-West direction to cut the West coast between latitudes 22° and 26° S. The belt includes the North-Eastern Goldfields, Murchison and West Gascoyne country.

Mulga (*Ac. aneura*) Typical mature form.

Mulga in the aboriginal tongue denotes hardness and is aptly applied to the extremely tough woods of the Acacia trees and shrubs of this arid region. From the pastoralist's point of view, however, it is better to confine the term to the tree-like forms of Acacia, occurring in the more Northern portion of the formation, coinciding with the increasing incidence of summer rainfall. In this paper the term Mulga will be confined to the tree-like Acacias of the Northern Murchison and not to the low Acacia scrub of the South.

The true Mulga, most forms of which appear to have the botanical characteristics of *Acacia aneura*, includes many diversified forms, which however, are all characterised by their tree-like habit of growth, their possession of terete to slightly flattened phyllodia and their cylindrical spikes of bright yellow flowers. Greatest variation occurs in the form of the phyllodia depending to some extent on the season, and the water relations of the habitats in which the individuals grow, but chiefly depending on specific or varietal characters. It appears possible that hybridisation has produced intermediate forms.

The possession of a main stem or trunk which rises to some 8-10 feet before producing a canopy of leaves and stems, distinguishes the Mulga from other Acacia of the formation. In some cases the stem rises vertically, bearing almost

horizontal lateral branches. This type is usually known as "Pine Mulga" due to its striking resemblance to this tree in its mode of growth. Other forms are less symmetrical in appearance, somewhat resembling the willow.

In contrast to the Mulga the Minerichi (*Acacia grasbyi*) and the Snakewood (*Acacia eremæa*) possess no main stem or trunk, the stem branching almost from the base and bearing a canopy of leaves some 5-10 feet above the ground. These shrubs displace the Mulga in the Southern Murchison.

Although, botanically, the Mulgas are apparently most difficult to classify, from the stock feeding point of view, they differ to a great degree. This difference is associated with edibility which is markedly varied within the several species or varieties. Some types are relished by stock, others are almost totally inedible.

Curara (lcft) and Hakea spp. on bank of watercourse.

Much information was gained on this point during a stay of some two weeks in an area where Mulga was being cut to feed sheep. Close observation of the feeding habits of the animals was possible giving the observer an accurate idea of the preference shown by the sheep for the various forms of Mulga.

It was at once apparent that certain types were decidedly more palatable to the sheep than others and furthermore that a definite range in edibility could be traced out. The definite selective grazing of the sheep was most impressive. First, the most edible type would be eaten out, the sheep rushing these bushes as they fell; then the sheep would go back through the felled patch and eat out the less edible types in a definite order leaving perhaps odd bushes of a most inedible type.

From cursory observations there appeared no explanation for this marked variation in palatability but after closer acquaintance with the vegetation it was noticeable that the Mulgas had for the most part a resinous covering over the phyllodia and stems giving these organs a somewhat varnished appearance. Others again possessed a whitish bloom which again appeared to have the possible function of reducing transpiration.

The various sub-species or varieties of Mulga varied greatly in their ability to elaborate this resinous-like principle, the extent of this varietal character largely determining the habitat of a given variety's most abundant growth. For instance, one found that the tendency was for the more edible species to be more numerous in the vicinity of watercourses and depressions where water relations would be most favourable. Conversely, varieties better adapted to production of the resinous exudate were found more abundantly on the drier slopes.

It was soon apparent that there was a correlation between the edibility of a variety and the amount of the protective secretion. The bushes possessing a shiny, varnished appearance were invariably inedible whilst edibility increased with decrease of this elaboration.

These generalised remarks on field observations have been to some extent substantiated by chemical analysis of samples obtained from the scrub-cutting areas. In these analyses comparisons have been based on the ether extract fraction. While not including all the exudate the ether extract should be a guide to the relative amounts in the various samples.

The table of analysis given below is for samples collected in two paddocks on Boolardy Station.

Samples of the various Mulgas were taken whilst the sheep were eating, notes being taken on each with regard to edibility.

TABLE I.

Samples from Long Pool Paddock.			*Samples from Bilaby Paddock.*		
No.	Ether Extract.	Notes on Edibility.	No.	Ether Extract.	Notes on Edibility.
	%			%	
1	6·5	Most edible Mulga in the area	1	5·7	Most edible Mulga
2	9·5	Much less edible than 1 ...	2	7·1	Quite edible, but less preferred than 1
3	10·6	Eaten, but less edible than 1 or 2	3	8·2	Fairly well eaten but of lower edibility
4	10·0	Not very edible	4	8·9	Low edibility
5	11·7	Very low edibility. Sheep do not eat except when forced on to it	5	7·32	Low edibility
6	12·0				

From the above analyses it can be seen that there is a definite correlation at least between the amount of the ether extract fraction and the edibility of the various Mulgas. Another point is that the Mulgas in the particular portion of the Long Pool paddock were generally inferior to those in Bilaby. This was realised by those on the scrub-cutting, and it was recognised as inferior country.

According to field observations the amount and nature of the resinous principle depends on:—

1. The age of the plant.
2. The variety of Mulga.
3. Seasonal conditions.

Points 3 and 2 have been discussed above and need not be further considered.

1. *Age of the Plant.*

In the young plant the reaction to drought and adverse conditions generally is most prominent and the secretion from the glands on trichomes is at a maximum. The root system, although well developed even in the youngest of plants, must of necessity be entirely inadequate during periods of prolonged drought. The encasement of the plant in a resinous "shell" serves to keep the plant in a state of dormancy until the break of the dry season.

Due to this increased production of secretory material young plants even of the most edible varieties are rarely touched by stock, in fact one may generalise and say they are inedible. It may be added that it appears probable that the exudate in the young plant is of different composition to that in the mature tree. For instance the bitter principle associated with the exudate is much more evident in the young than in the mature plant.

Annual Trichinium spp. appearing after rain on Mulga flats.

Further analysis and separation of the constituents of the resinous exudate is required before anything further can be said on this point.

The result of a feeding experiment with penned sheep on Boolardy Station regarding the relative edibility of the young and mature trees may be given here. The experiment was carried out to substantiate the general conclusion that the plant in its young stages was inedible to stock.

Small branches cut from a Mulga of some 4 feet in height were fed to sheep together with branches from a mature tree. Both young and old trees were of the same variety and were growing within a few yards of one another. Within an hour of feeding, all the branches from the mature tree had been stripped, whilst the young growth remained absolutely untouched. The branches were left in the pens with the idea that the sheep would perhaps reconsider the apparently inedible young growth when their hunger increased. Fifteen hours later, at the time coinciding with the early morning feed, the bundles remained untouched as on the night before, in spite of the fact that the sheep were ravenous for further feed. After two days the bundles of branches which still remained

untouched, were removed from the pens. The branches from the young Mulga were in the same condition as when placed in the pens some three days before. No attempt had been made by the sheep to eat them.

The position is therefore singularly fortunate for the plant in that the secretion primarily elaborated as a protection against adverse climatic conditions also acts as a barrier to the ravages of stock. This applies particularly to the plant under 4 feet in height. From 4-6 feet the tips of the branches may be nibbled by sheep but the tree sustains no great injury. As the tree grows the edibility increases, but even in trees of 10-12 feet the edibility is still low as shown by the way bullocks and camels leave these trees for those more mature.

It has been noted on occasions when immature trees have been cut that the sheep may eat the upper 2-3 feet but leave the lower branches entirely untouched. This seems to point to the fact that there is a fairly definite point at which active secretion by the trichomes is to some extent arrested.

W. A. Cannon (7) in his observations on desert plants in South Africa touches on this point, observing that as the plant matures the number of trichomes or secretory glands occurring on the leaves or phyllodia is reduced. It is possible that the transitional period may coincide with the time at which full development of the root system occurs.

Annual Trichinium spp. after rain on Mulga flats.

From the regeneration point of view the importance of the above fact is of the greatest magnitude. It means that during the period when the plant is most accessible and, one would think, most desirable as a stock feed, it is protected from grazing animals by the elaboration of a distasteful principle primarily produced to help it withstand periods of adverse climatic conditions. Without this protection in the young state the chances of regeneration of Mulga country in the stocked areas would be exceedingly small.

The time taken to reach maturity in the case of the Mulga is comparatively long, probably some 30-40 years depending largely on the nature of the seasons during the period of its growth. During favourable seasons its growth is rapid while periods of dormancy coinciding with dry seasons are only too frequent. The growth of the Mulga plant can best be described as spasmodic rather than slow. Immature trees of some 10 feet in height have been said to be 15 years old. Probably double that period is required for the tree to reach maturity, although, as before said, conditions of season and habitat may prolong or decrease this period.

Regeneration.

The almost entire absence of young growth within the Mulga country is a point stressed by many observers and has led to the conclusion that regeneration is practically non-existent. It is, however, not until the competition of the larger trees has been removed by cutting or depredation of drought that the young growth appears. The extensive lateral development of the root system of the Mulga which lies within a few inches of the surface precludes competition of the young plants.

The following table was compiled from information of a survey of an area where regeneration was taking place following the cutting out of the larger trees some twenty to thirty years ago. The table is designed to give the proportion of young growth to mature Mulgas.

TABLE II.

Traverse.	No. of Mulgas.		Total.	Percentage Young to Old Mulgas.
	< 10 ft.	> 10 ft.		
				%
No. 1	117	28	145	417
No. 2	152	30	182	507
No. 3	150	69	219	232
No. 4	153	82	235	186
No. 5	132	89	221	148
No. 6	64	118	182	55
No. 7	73	135	208	54
No. 8	63	164	227	38
No. 9	69	172	241	40

Transect Nos. 1-3 pass through the fringe of the Mulga thicket which has been most heavily cut out, whilst Nos. 4-9 show the gradual passage into the virgin Mulga. The increasing number of young Mulgas in the former region demonstrates the permissive effect the removal of the mature trees has on regeneration.

It is in areas where the mature growth has been removed by cutting, as for instance in the mining areas of the Murchison (Cue, Meekatharra, Wiluna), that regeneration is most noticeable.

With regard to regeneration generally, it must be realised that rate of regrowth is naturally very variable within the several types of country. In the habitats most favourable to the growth of the Mulga regeneration is comparatively

fast, whereas on less favourable sites a long period of time may pass before the vegetation becomes re-established. Cutting on such marginal land if practised at all should be carried out with the greatest caution.

It is on such places that soil erosion may possibly become a menace. It is most unlikely, however, that conditions comparable to those prevailing in the arid portion of South Australia could possibly occur even in the most open country on the Murchison. The difference in soil type, the apparent absence of the rabbit in large numbers, (due to the character of the soil profile precluding burrowing) and the marked way in which regeneration of the Acacia shrubs takes place, are conditions very much in contrast to the position in South Australia as described by Ratcliffe (8). The Saltbush of all associations is the one most liable to extinction, but this does not occur except in cases of gross overstocking. The Saltbush occurs only in limited areas on the West Murchison.

Regeneration of Mulga 8-10 feet in height. Germinated about 1918.

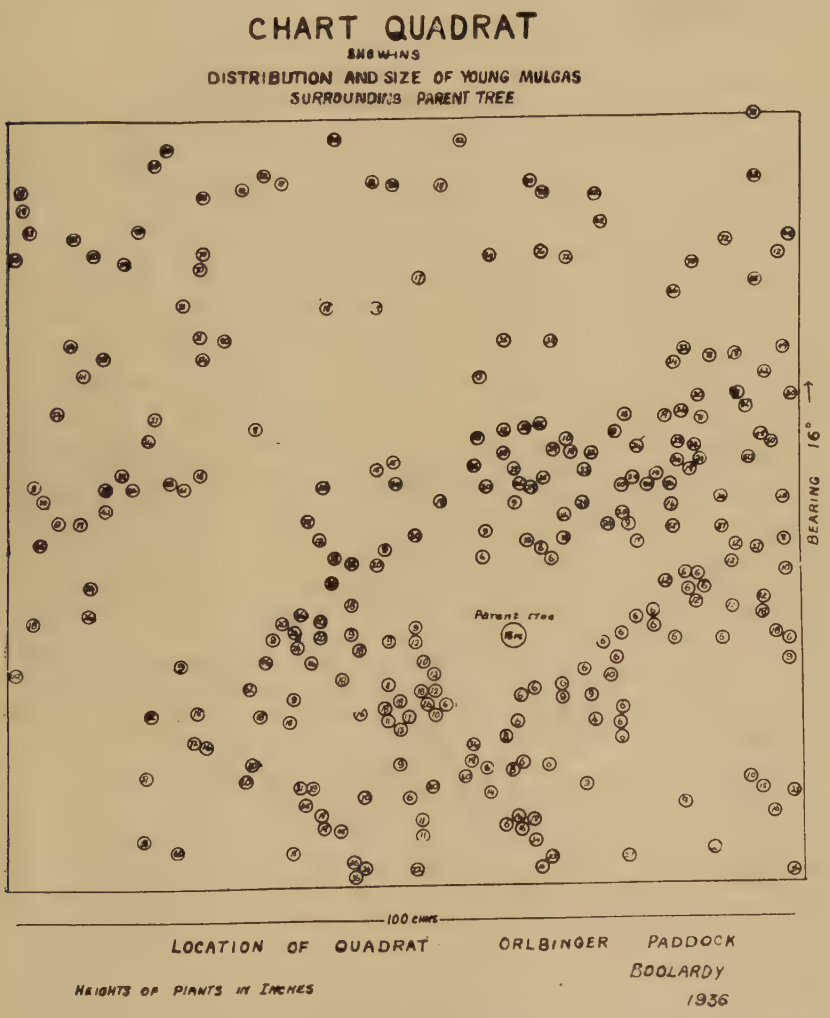
The paddocks surrounding the Boolardy homestead gave a good illustration of Mulga regeneration and provided a suitable area for study. In this area most of the mature trees had been cut out for requirements of the homestead such as posts and building material some 20-30 years ago. Today these paddocks are covered with young growth much denser than the original vegetation could have been. A point to be emphasised is that these paddocks have been carrying stock during this period and being in the vicinity of the shearing shed are used to some extent as holding paddocks.

The first impression gained in such a regenerating area is that the young growth is all more or less of standard heights. To illustrate this point reference may be made to the above area in which some time was spent. Here, for instance, there seemed to be a preponderance of young plants of about 4 feet high with fewer plants at 1-2 feet. One could also distinguish another group of 6 feet

in height and another at about 10 feet. Many intermediate sizes were of course present but the general impression was that the young Mulgas fell to a large extent into these size groups.

The conclusion to be drawn is that seasons favourable to germination and continued growth of the young plants occur only once in a number of years, probably something like once in five years.

To illustrate the extent to which the Mulga will regenerate, a quadrat was mapped out in a position on the margin of the regenerating Mulga thickets. Very few of the mature trees still remained in this area, the particular tree about which the quadrat centred being the only mature Mulga within a radius of some 2-3 chains.



The accompanying chart represents an area of 1 chain square and shows the position and heights in inches of the young plants surrounding the parent tree. It will be readily noticeable from the chart that the larger plants occur

furthest from the parent where competition is least. Such competition is restricted to water requirements, as light, as a factor limiting growth, could not be of any consequence in such a climate.

The smaller plants which are stunted in appearance occur closer to the parent. They appear to reach a certain stage of growth beyond which further development is impossible, due to the competition of the parent roots. Such plants probably linger and die making way for a further crop of seedlings, which however meet the same fate.

The competition in the virgin thickets of Mulga is such that survival of the young plants beyond the seedling stage is impossible. The graduation in sizes of the young Mulgas is not very well illustrated by the chart, being masked by the competitive effect of the parent plant.

The Mulga, like most of the Acacias, produces extremely hard seeds which are particularly resistant to climatic factors. The testas of the seed are thick and much soaking is required to penetrate them.

It appears then that it is only during periods when the country is flooded, (which is a periodic occurrence on the Murchison) that the seeds have the opportunity of germinating. Also the temperature range within which such seeds will germinate appears to be narrow. It will be realised then, that conditions for maximum germination occur only at infrequent periods.

The incidence of rains during the summer season appears to be most conductive to successful germination of seeds of the perennial vegetation. This fact is possibly the reason for the restriction of the true Mulga to the summer rainfall areas.

What has been said regarding the regeneration of the Mulga and the relation of the young plant to stocking is generally applicable to the majority of the vegetation.

It was noticed that the young Curara and Black Wattles were both generally disliked by stock, whilst the mature plants of these species are amongst the most edible plants of the Murchison. It may be taken as a general rule that the perennial Acacia vegetation is less edible in the young than in the mature stage.

The conclusion arrived at was that the effect of stocking on the regeneration of the vegetation is not as important as one might imagine. Unfavourable seasonal conditions appear to be by far the most important factor limiting regrowth.

5.—DROUGHT CONDITION.

The drought of 1935-36 will stand in the records of pastoral development as the most disastrous known, up till that time, in the Murchison district.

Losses of stock have been tragic and the extent of the deterioration of the country due to the dying out of the vegetation during this period has yet to be assessed.

The position during 1936 has been that ground feed was entirely absent. All low perennials such as Saltbushes, edible *Eremophila* species etc., have been defoliated and the larger shrubs have been eaten as high as the animals can reach. The

feed remaining consists of coarse inferior shrubs together with leaves and refuse that may fall from the larger shrubs and trees; all of which would be entirely inedible during even an ordinary dry year.

The almost denuded bushes with their tufts of foliage borne out of reach of the stock, give a singularly desolate appearance to the country. The only green within four to five feet of the ground consists of scattered Turpentine bushes (*Eremophila Fraseri*) and various inedible Acacia and Cassias. It seems incredible on viewing the country, that stock can still subsist on an area so destitute of fodder material. Only the remarkable constitution bred into the sheep by years of careful selection has saved the Murchison from complete loss of its sheep population.

During this year the stage appears to have been reached where due to the scarcity of feed, the time of feeding is insufficiently long for the sheep to fulfil its requirements.

According to Cory (9) in some work done on sheep and cattle under range conditions in Texas, about 13 per cent. of the sheep's time is spent in travelling, the balance he attributes to periods of resting, rumination and idling.

Under the abnormal conditions prevailing in the Murchison the time of travelling is quite inadequate for the sheep to obtain its feed requirements, with a consequent increased waste of energy and decreased period of resting and rumination. Despite the watering facilities available to the sheep, water is still a factor limiting the area over which the animal can travel in a day. Especially is this so in the hot months when the sheep visit water at least once a day. The section of the paddock in which a sheep grazes is also limited by the animal's refusal to drink from wells other than the one to which it is accustomed. Sheep appear particularly susceptible to changes in the character of the drinking water, and once they have become used to drinking water from a certain well it is particularly difficult to introduce them to another. The result is that the stock are restricted to the plant associations within normal travelling distance of the mill at which they are accustomed to drink. On the feed value and edibility of the constituent plants of these associations depends the welfare of the sheep.

During such dry periods it is noticeable that the condition of the stock at different wells varies considerably. While sheep watering at one mill are in fair condition the animals at the next mill may be dying of starvation.

The increased waste of energy in travelling, together with the low nutritive value and scarcity of feed are, one could say with some certainty, the causes of the drastic losses of stock during the last two years. At present one sheep to 100 acres is probably the maximum stocking capacity of a greater part of the country.

A factor which further decreases the amount of feed is the fact that certain shrubs, particularly Curara, respond to the drought condition by losing most of their leaves and in so doing reduce their transpiring surface. Considering the eminent position of the Curara (*Ac. tetragonophylla*) as a fodder, the importance of this phenomenon cannot be overlooked. The fallen leaves (phyllodia) do not seem to be eaten to any extent.

Another factor which assumes importance during drought periods is the competition between the kangaroo and the sheep for the remaining feed. The watering facilities which have made the increase in the sheep population possible have

also benefited the kangaroo with the result that, despite the thousands of these animals which are killed yearly, they must now assume far greater proportions than before the pastoral development of the country took place. The kangaroo has the advantage of being migratory in nature, following the thunderstorms and the resulting green picking. The sheep, confined by fences to a limited area must of necessity be content with the feed available in that area. The native animal has the further advantage of being able to reach higher up into the foliage of the shrubs.

Notwithstanding this, however, the sheep appear to be able to stand up to the conditions as well, if not better, than the kangaroo. During the drought it was noticeable that the mortality amongst the kangaroos was quite as great as amongst the sheep.

The most serious aspect regarding the kangaroo menace is that "spelling" of paddocks from sheep merely means the encouragement of the kangaroo. Until the kangaroo is controlled, any scheme of conservation of paddocks for drought feeding must of necessity be impracticable if not futile.

The fluctuation in the feed supply is nowhere so great as in the topfeed country where the bulk of the perennial vegetation is inaccessible to stock. In the Murchison where Acacia shrubs, which attain almost tree-like proportions, form almost the entire perennial growth, only a small proportion is available as feed. The low growing vegetation is mostly of an ephemeral nature appearing in abundance only during a good season. With the approach of the dry season this growth dries out and is blown away in the hot blast of winds. The stock are then forced on to the limited amount of topfeed accessible to them. In the Spinifex areas, to take a comparison, the bulk of the vegetation is at all times available to stock. We still have the lowering of the carrying capacity during the dry season but the fluctuation is nowhere as great as in the Murchison. For this reason the Spinifex is recognised to possess double the carrying capacity of the Mulga country.

Utilisation of the surplus feed from the good season and discreet use of the topfeeds in making them available to stock appear to be distinct possibilities in alleviating the poor feeding conditions prevailing in the Mulga areas during drought years.

In conclusion it may be remarked that the excellent quality of the wools produced in this region must in no small way be due to the particularly high nutritive value of the Acacia shrub and bushes. Every effort should be made therefore to protect and foster their growth at the same time making full use of their valuable feeding properties.

The productivity of the Murchison country for pastoral pursuits depends on the continued existence of the Acacia topfeeds and any action which may prove detrimental to their existence can only have the effect of seriously aggravating the drought problem.

6.—SUMMARY.

1. An account of the chief physical features of the Western Murchison is given together with a general account of vegetation types.

2. A description of a more detailed survey of a representative area on the Roderick River is included.

3. Observations on Boolardy Station with regard to sheep being fed on Mulga are described, and the theory of edibility being related to the amount and nature of the resinous exudate produced by these plants is advanced.

4. The chief problems of the area appear to arise from:
   (a) The extreme fluctuation in production from year to year due to climatic variation.
   (b) The difficulty of retaining breeding stock during periods of drought.

5. Possible solutions to these problems may lie in:
   (a) The controlled exploitation of the resources of inaccessible topfeeds (Mulga) during drought periods.
   (b) Conservation of the over-abundant ephemeral growth in the form of hay, etc.

7.—ACKNOWLEDGMENTS.

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Wheat Variety Trials on Research Stations.

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Field Day at Wongan Hills Research Station, 1946—Inspecting the Wheat and Oat Variety Trials.

WHEAT Variety Trials conducted on the Research Stations served to test a number of new varieties against Bencubbin and Bungulla, the standard mid-season and early maturing varieties respectively, which between them were sown to over 55% of the 1946 acreage in Western Australia. As in previous years an endeavour was made to include the new rust resistant varieties released in other States, but shipping delays resulted in one of these, Celebration, arriving too late for planting. Also tested for the first time were six cross-breds from the Merredin and one from the Wongan Hills Research Station.

Seasonal Conditions.

The season was characterised over most of the wheatbelt by above average winter rainfall with no useful rains after the beginning of September. At Salmon Gums no rain fell before mid-June but this was supplemented by above average September falls not recorded elsewhere. Details of the Research Station rainfalls are given in Table 1.

TABLE NO. 1.

Year.	Jan.	Feb.	Mar.	Apl.	Growing Period Rainfall							Nov.	Dec.	Annual Total.
					May.	June.	July.	Aug.	Sept.	Oct.	Total.			
Merredin, 1946	2	24	3	52	203	305	375	187	94	5	1,169	78	0	1,328
Average	45	57	98	88	137	192	179	154	81	74	818	40	60	1,206
Wongan Hills, 1946	0	33	21	201	244	444	447	197	18	2	1,352	106	0	1,713
Average	63	49	100	87	189	263	252	207	95	69	1,075	41	45	1,432
Chapman, 1946	4	24	16	102	160	597	852	229	27	3	1,868	193	12	2,219
Average	28	39	68	72	233	427	384	267	148	85	1,547	35	27	1,815
Avondale, 1946	3	0	3	86	348	786	665	182	15	1	1,997	99	14	1,954
Average	26	40	111	79	221	327	299	252	107	80	1,287	46	34	1,622
Salmon Gums, 1946	15	0	0	14	42	275	207	115	170	45	854	92	47	1,022
Average	91	71	149	92	130	149	142	152	90	111	774	88	84	1,348

The abnormally wet winter and the following very dry spring were not conducive to average yields in the most reliable wheat-growing areas but some of the drier and marginal districts experienced a satisfactory season.

The earlier plantings in the higher rainfall districts were mostly badly waterlogged in the winter, and subsequently severely attacked by the take-all complex of diseases. However, several crops in these districts sown on pea stubble gave satisfactory yields despite the adverse conditions.

Brush enclosures at the Merredin and Wongan Hills Research Station, where with the help of irrigation artificial rust epidemics are produced for testing new crossbreds.

Rust Resistance.

Widespread rust damage was experienced in South Australia during 1946 and, as with epidemics in this State (Cass Smith and Millington, 1944), the outbreak of the disease was preceded by heavy summer rains. The self sown crops, which germinated after these rains, on stubble land became heavily in-

fected with rust and the disease spread during the winter to the adjacent autumn sown paddocks. (A. T. Pugsley, 1946). When at planting time nearby paddocks contain self-sown crops heavily infected with rust, the hazard of an epidemic of that disease during the season must be rated very high.

The losses from rust can best be minimised by having on hand substantial supplies of resistant varieties for planting in such seasons of high rust hazard.

No rust has occurred on crops in epidemic form in W.A. for four years, but in view of recent developments in the other States it is uncertain whether Eureka and its derivatives will continue to be resistant. In New South Wales and more recently in other States, a strain of rust has appeared which attacks the hitherto resistant variety Eureka. The Department of Agriculture therefore, seeks the co-operation of farmers in obtaining rusted wheat plants and as soon as the disease is observed specimen plants should be forwarded to the Government Plant Pathologist, Department of Agriculture, Perth.

The farming industry is deeply indebted to the New South Wales Department of Agriculture for its enterprise in collecting varieties from all parts of the world, and subjecting them to tests for rust resistance. From Kenya Colony varieties were obtained which are resistant to the new rust race as well as the old and their resistance has been incorporated in varieties suited to Australian conditions.

TABLE NO. 2.

Breeder.	Type of Resistance.			
	A. Eureka.	B. Kenya C6041.	C. Kenya C6042.	Mature D. Plant.
New South Wales Department of Agriculture ...	Eureka Frisco	... ...	Charter Yalta	Celebration
W.A. Department of Agriculture	M.78 M.79 M.80 M.81	M.70 M.71	... ...	... ...
Sydney University	...	...	Gabo Kendee	Hofed Fedweb
Waite Institute	...	...	...	Warigo

Data published by Drs. Waterhouse and Watson for the Sydney University forms the basis of Table II. which classifies the type of resistance possessed by the rust resistant varieties now under cultivation in Australia or undergoing advanced trials. For very rust liable districts in W.A. it would be advisable to have on hand reserves of varieties possessing the B, C or D types of resistance rather than the A or Eureka type.

MERREDIN RESEARCH STATION, TABLE III.

Variety.	Flour Strength.				Yield.		
	Farinograph.		P.T.	D.G.	Yield.	Control, 1946.	Average. No. yrs. ().
	S.F.	W.A.					
		%			Bus. lb.	%	%
Early Planted Trial:							
Bencubbin (Control)...	8·2	64·7	65	13·4	22 5	100	100 (3)
Eureka	21·5	65·6	146	13·6	19 47	90	84 (3)
Kondut	15·7	64·0	134	12·4	18 24	83	73 (3)
Koorda	8·6	61·5	70	14·3	17 39	80	...
Difference for significance (P = ·05) ...	...	...	...	...	2 21	12	...
Late May Trial:							
Bungulla (Control) ...	9·4	64·0	59	13·4	20 47	100	...
Charter	20·8	70·0	128	15·4	18 51	91	89 (3)
M.71	8·4	60·6	75	14·4	19 30	94	...
M.78	22·2	65·8	125	13·3	19 51	96	...
M.79	13·8	65·7	74	16·0	21 11	102	...
M.81	10·6	68·8	63	14·0	21 30	104	...
W.12	16·6	65·4	104	13·5	17 52	86	...
Difference for significance (P = ·05) ...	...	...	...	...	1 39	8	...
Late May-June Trial:							
Bungulla (Control) ...	8·1	62·2	57	11·5	21 2	100	...
Charter	19·2	69·6	129	16·0	21 41	103	...
Gabo	15·9	73·4	88	14·0	19 44	94	...
Kendee	19·7	67·9	119	14·6	20 11	96	...
M.77	17·1	70·0	76	13·4	22 29	107	...
M.80	14·4	66·7	123	12·2	23 55	114	...
Difference for significance (P = ·05) ...	...	...	...	...	1 10	6	...

S.F. = Strength figure.
W.A. = Water absorption.
P.T. = Pelshenke time in minutes.
D.G. = Percentage of dry gluten.

Flour Strength.

This year Table III giving the results from the Merredin Research Station includes data on the strength of the individual varieties and this makes it desirable to explain the significance of these tests. The baking quality of wheat or flour may be defined as the suitability of the flour for the required purpose and the strength of a wheat or flour is the fundamental property which governs its quality. Thus a weak flour may be more suitable than is a strong flour (and therefore of better baking quality) for cakes, home-baking, self-rising flour or certain types of biscuits.

In wheat breeding, tests are made of the strength of the varieties to determine their quality, i.e., to determine the purpose for which they are suitable and since the greater proportion of flour is used for breadmaking the results

of the tests are usually evaluated as for bread flours. There is no single test for strength which is entirely satisfactory so three different tests are used by the Department when sufficient wheat is available. These three tests are:

(1) The Pelshenke time or wholemeal fermentation time test.
(2) The Gluten test, and
(3) The Farinograph strength figure.

For comparison of the data shown in Table III. it may be noted that the 1945-46 f.a.q. sample had a Pelshenke time of 33mins., a dry gluten content of 7.4% and a strength figure of 4.8 mins.

These tests and their relationship were described by Samuel (1938) but are briefly as follows:—

1. The Pelshenke test is applied to the wheat, which is ground to pass a 1 mm. sieve (25.4mm equals 1in.) and 5 grams of the meal made into a doughball with the requisite distilled water containing 0.25 gram of yeast. This doughball is immediately immersed in water maintained at 32°C. In 10-15 mins. the gas produced by the yeast fermentation inflates the doughball so that it floats. Further fermentation causes further expansion of the ball until finally it disintegrates. The Pelshenke time is the time in minutes from the immersion of the doughball in water to the first disintegration. The longer the time the stronger the wheat.

2. The gluten content is determined on the flour by making a doughball of 10 g. of flour with the requisite water, allowing the ball to stand one hour in water, and then kneading it in running water. This washes away the starch as a milky liquid and leaves the gluten as a coherent, yellow to yellow-brown soft rubbery mass which is dried and weighed. The greater the gluten content the stronger the flour but the strength is also dependent on the type of gluten in the flour.

3. The Farinograph operates on the flour and is essentially a self recording dough mixer which records the electrical power necessary to mix a dough of standard consistency and records the change in power with continued mixing of the dough.

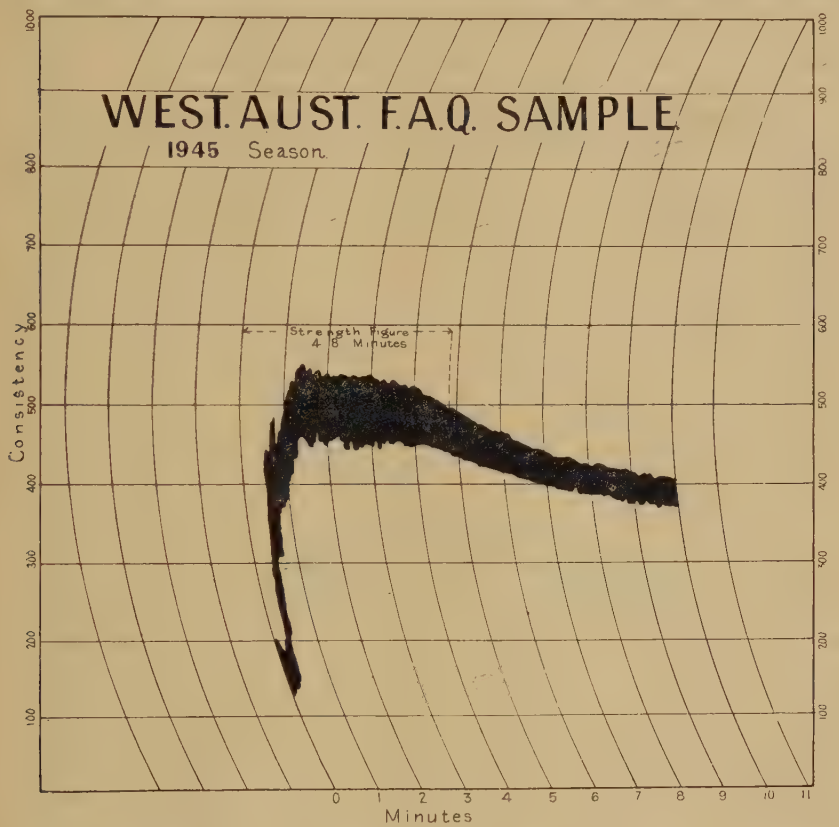
Initially the graph of the power required rises to a maximum as the flour and water are mixed to a dough, remains at a maximum for a period of time which varies with the strength of the flour, and then decreases. The farinograph strength figure is the time in minutes from the beginning of mixing until the top of the grain falls below the level of the mid-point of the graph at maximum consistency. The longer the time, the higher the strength figure and the stronger the flour.

The water absorption, while not a valid measure of strength, is important, as the greater the water absorption the greater the yield of bread from a given quantity of flour.

In evaluating the results of the tests of the Variety Trial at the Merredin Research Station for suitability for bread-making it may be noted that good bread can be made from flours of widely different strengths, provided the bread-making technique is altered to suit the flour but, in general, the bread-making technique is relatively fixed and for a flour to give good bread its strength must be suitable for the practice of the baker. On the world's market and in particular, on the English market, West Australian f.a.q. is classified as too weak to make satisfactory bread. Thus when using West Australian wheat the overseas miller needs to include in his grist a wheat sufficiently strong to raise the resultant flour to the required strength. This imposes two limits on the amount

of West Australian wheat which can be so used, firstly by the availability of the strong wheats and secondly by the price, for normally the strong wheats command a higher price.

To avoid this limitation, a primary object of the wheat breeding programme in this State is to raise the strength of the West Australian f.a.q. wheat to the level that it does not need assistance from, or building up by, a strong wheat. This strength is referred to as a "filler" wheat since after the miller has adjusted the proportions of strong and weak wheats in his blend he can use an unlimited amount of filler wheat without materially altering the strength of the resultant flour.


WEST. AUST. F.A.Q. SAMPLE.
1945 Season.
Strength Figure
4 5 Minutes
Consistency
Minutes
0 1 2 3 4 5 6 7 8 9 10 11
100 200 300 400 500 600 700 800 900 1000

It is considered that the strength tests of these wheats from the Merredin Research Station show that the popular varieties are capable of filler strength under suitable soil and climatic conditions. The areas proposed to be sown to Bencubbin and Bungulla in the 1946-47 season were some 35% and 21% respectively of the total area to be sown.

Thus our present varieties have bred into them sufficient strength for filler wheats if growth conditions permit them to develop their inherent strength. This directs attention to the growth conditions as distinct from the continuation of the breeding programme to evolve varieties which will be of filler strength under present growing conditions of soil fertility and climate.

Strength and Environment.

The variability of the strength of an individual variety of wheat is illustrated in Table IV. showing the results of the strength tests of three varieties grown at five Research Stations in the 1945 season.

TABLE IV.

VARIATION IN FLOUR STRENGTH WITH SOIL AND CLIMATIC CONDITIONS.

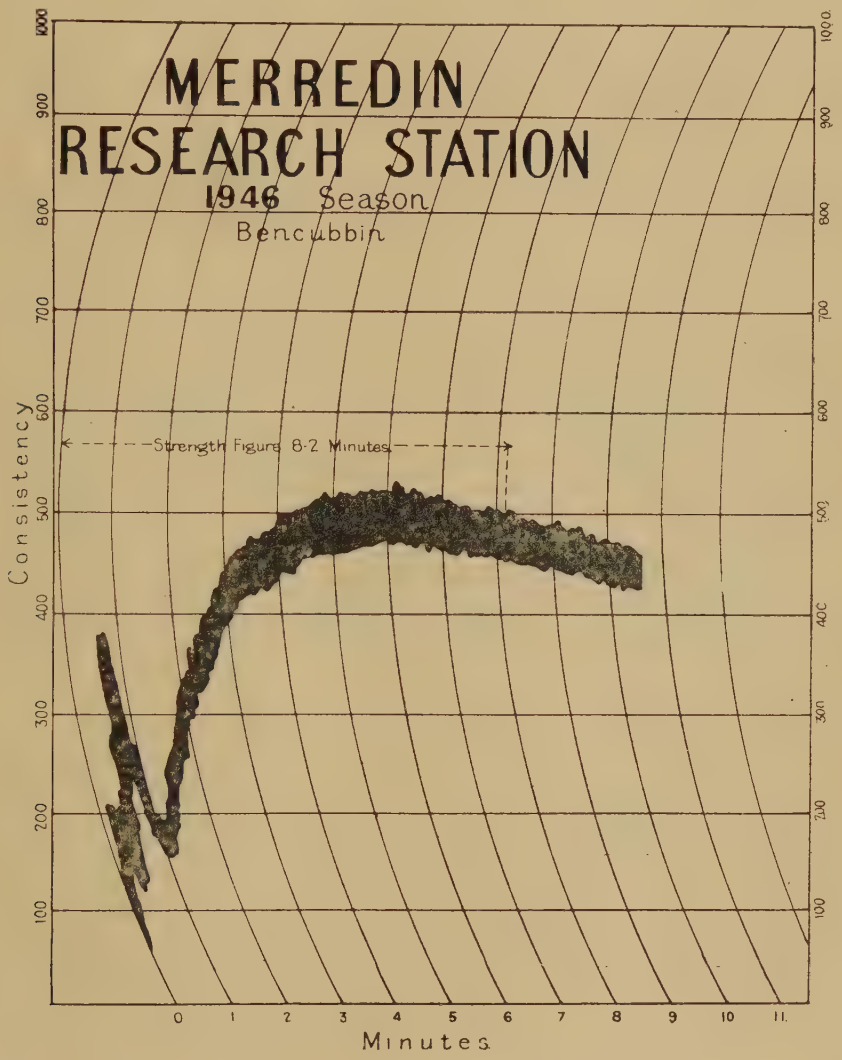
Data from various Research Stations, 1945–46 season.

Variety and Source.	Bencubbin.			Eureka.			Kondut.		
Avondale.									
Strength figure (mins.) ...	2·6	...	...	2·6	...	...	2·0	...	...
Pelshenke time (mins.) ...	...	37	...	...	32	...	...	30	...
Dry gluten %	...	...	5·0	...	...	5·5	...	...	5·0
Specific protein strength from strength figure ...	0·5	...	...	0·5	...	...	0·4	...	...
Pelshenke time	...	7·4	...	...	5·8	...	...	6·0	...
Chapman:									
Strength figure (mins.) ...	2·5	...	...	2·7	...	...	2·5	...	...
Pelshenke time (mins) ...	...	44	...	...	45	...	...	44	...
Dry gluten %	...	...	5·4	...	...	6·4	...	...	6·2
Specific protein strength from strength figure ...	0·5	...	...	0·4	...	...	0·4	...	...
Pelshenke time	...	8·1	...	...	7·0	...	...	7·1	...
Merredin:									
Strength figure (mins.) ...	9·4	...	...	13·4	...	...	14·3	...	...
Pelshenke time (mins.) ...	...	46	...	...	85	...	...	87	...
Dry gluten %	...	...	9·3	...	...	10·2	...	...	13·2
Specific protein strength from strength figure ...	1·0	...	...	1·3	...	...	1·1	...	...
Pelshenke time	...	4·9	...	...	8·3	...	...	6·6	...
Salmon Gums:									
Strength figure (mins.) ...	3·3	...	...	6·4	...	...	6·2	...	...
Pelshenke time (mins.) ...	...	39	...	...	61	...	...	61	...
Dry gluten %	...	...	7·2	...	...	8·4	...	...	8·3
Specific protein strength from strength figure ...	0·5	...	...	0·8	...	...	0·7	...	...
Pelshenke time	...	5·4	...	...	7·3	...	...	7·3	...
Wongan Hills:									
Strength figure (mins) ...	2·4	...	...	4·7	...	...	2·5	...	...
Pelshenke time	...	36	...	...	37	...	...	34	...
Dry gluten %	...	...	5·4	...	...	7·8	...	...	6·2
Specific protein strength from strength figure ...	0·4	...	...	0·6	...	...	0·4	...	...
Pelshenke time	...	6·7	...	...	4·7	...	...	5·5	...

In Table IV. two new factors for strength have been calculated. These may be defined as (a) the strength figure per per cent. of dry gluten and (b) the Pelshenke time per per cent. of dry gluten and are obtained by dividing the strength figure and Pelshenke time respectively by the percentage of dry gluten. Since the specific protein strength for a variety does not vary as markedly as either figure or the Pelshenke time the main reason for the difference in strength of the same variety from different Research Stations is the difference in gluten content. However, since the specific protein strength does vary, the evidence from this and other data is that the strength of the gluten of an individual variety does vary with growth conditions.

In a previous issue of this Journal (Samuel, 1945) data was published to show the marked effect which crop rotation can have on flour strength as well as on yield. The inclusion of a legume in the rotation, particularly on the lighter

soil types usually materially improves both flour strength and yield. The increments will be smaller after very wet winters such as those of 1945 and 1946, particularly if the crop is sown on fallow. Any substantial increase in the flour strength of the W.A. f.a.q. will be dependent not only on the cultivation of inherently stronger flour varieties but also on the more extensive use of legumes. That the latter is likely is snown by the increased areas of First Early (Dwalganup) sub-clover on the lighter soils of the 14-18" rainfall belt as evidenced by the planting during the war years in one Midlands district alone of 100,000 acres to this legume.



New Varieties.

The four new varieties tested were Frisco, Yalta, Gabo and Kendee. All are resistant to the strains of rust collected so far in Western Australia, but Frisco is susceptible to the new type which is present in the Eastern States.

WHEAT VARIETY TRIALS—TABLE V.

Variety.	Avondale.			Chapman.			Salmon Gums.			Wongan Hills.		
	Yield.	Percentage of Control.		Yield.	Percentage of Control.		Yield.	Percentage of Control.		Yield.	Percentage of Control.	
		1946.	Average.		1946.	Average.		1946.	Average.		1946.	Average.
Early May Trial:	Bus. lb.			Bus. lb.			Bus. lb.			Bus. lb.		
Bencubbin ...	10 54	100	100 (3)	5 26	100	100 (3)	14 56	100	100 (3)	5 49	100	100 (2)
Eureka	10 30	97	89 (3)	4 6	75	76 (3)	12 0	80	83 (3)	5 57	102	89 (2)
Kondut	11 36	107	94 (3)	5 2	93	90 (3)	12 35	84	83 (3)	5 17	91	82 (2)
Koorda	...	...	...	4 58	91	...	...	...	...	4 39	79	...
Frisco	...	...	...	5 31	101	...	...	...	...	...	...	...
Yalta	...	...	...	6 22	117	...	...	...	...	...	...	...
M.75	10 0	91	...	...	...	...	13 14	89	...	...	...	...
Difference for significance	0 51	8	...	0 32	10	...	1 43	11	...	0 34	10	...
Late May Trial:												
Bungulla	16 42	100	100 (3)	9 12	100	100 (3)	14 24	100	100 (3)	17 38	100	100 (3)
Charter	15 36	93	88 (2)	6 51	75	91 (3)	15 6	104	94 (2)	15 20	87	77 (3)
M.71	...	...	...	8 42	94	...	...	...	...	...	...	...
M.77	18 36	111	...	9 14	100	...	14 50	103	...	16 58	96	...
M.78	...	...	...	8 46	95	...	...	...	...	...	...	...
M.79	...	...	...	8 22	91	...	15 6	104	...	17 52	101	...
M.80	16 42	100	...	8 19	90	...	16 16	113	...	16 7	91	...
M.81	17 36	105	...	...	...	...	...	...	...	19 17	109	...
Koorda	...	...	...	...	...	...	13 58	97	91 (3)	...	...	...
Difference for significance	1 55	11	...	1 3	12	...	0 55	6	...	1 28	9	...

Yalta and Frisco were bred by the New South Wales Department of Agriculture, whilst Gabo and Kendee were released by the Sydney University. Sufficient seed of these varieties was available for trials at one Station only, but they will be more widely tested during the coming season. In general, as will be seen from the yields given in Table V., they promise to be very useful varieties.

Difference for Significance.

Two adjacent plots sown on the one day to the same variety and with identical fertiliser treatment will not give equal yields because of uncontrollable factors, such as soil variability. It is possible, however, to calculate in bushels per acre for any correctly designed experiment, the allowance which must be made for the uncontrollable factors and this figure appears in the line "Difference for significance. P = .05."

Portion of a Wheat Variety Trial—Merredin Research Station, 1946. Each plot is one-eighth of an acre and is replicated five times in Randomised Blocks.

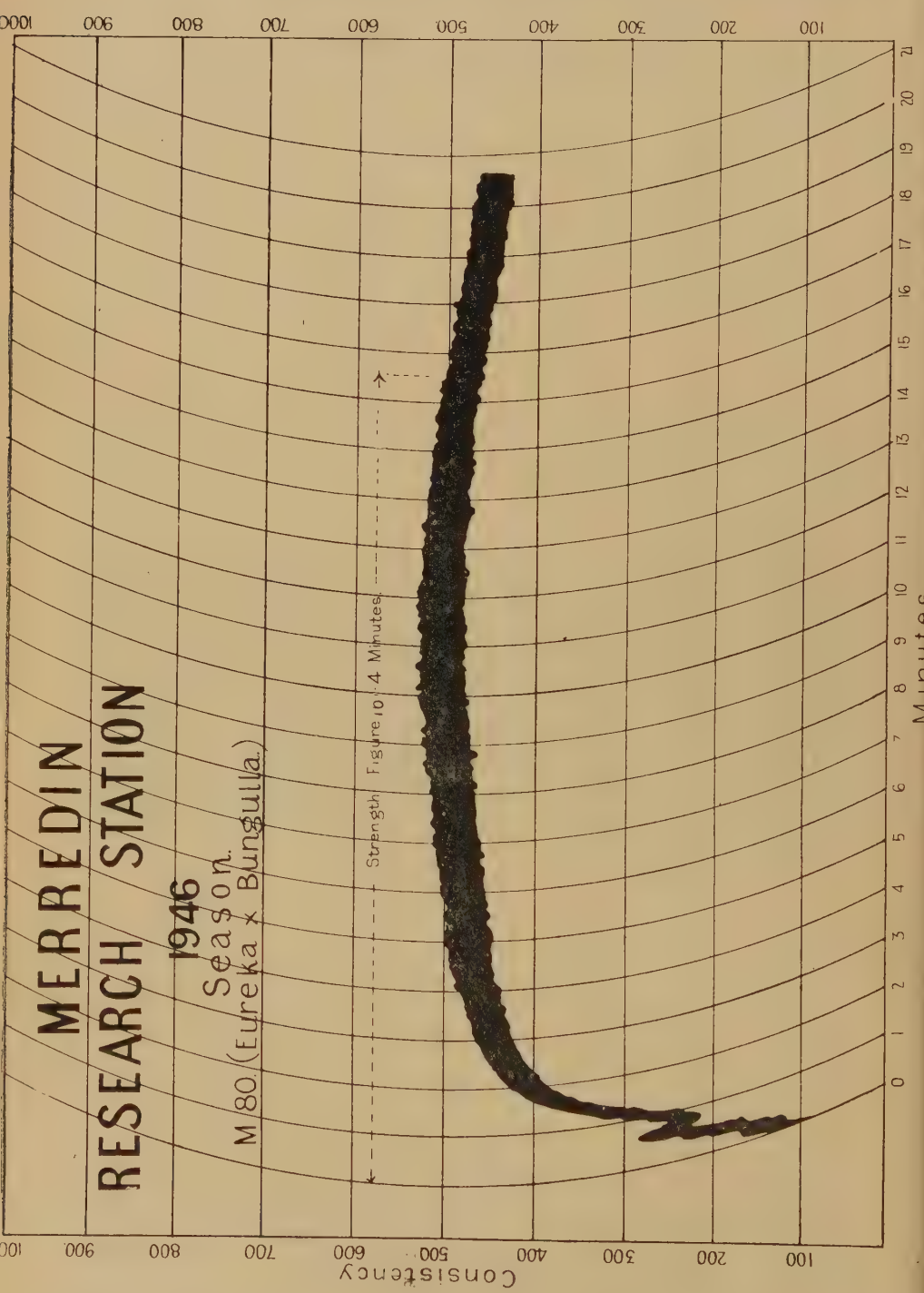
If one variety yields 10 bushels and another 15, i.e. by a margin of 5 bushels, and the "difference for Significance" is 3 bushels, then the higher yielding one significantly outyielded the other. If the margin had been two instead of five bushels, the difference would not be significant. It would be assumed that the varieties are equal in yielding ability and that the difference in yield, 2 bus./acre was due to soil variability and similar uncontrollable sources of variation.

New Crossbreds.

Crossbreds produced at the Merredin Research Station carry the prefix "M" and those from Wongan Hills "W".

Sword x Kenya C6041. M.71. An early maturing variety tested for the first time. M.71 yielded fairly well and will be included in further trials. It is resistant to the Eureka attacking strain of rust.

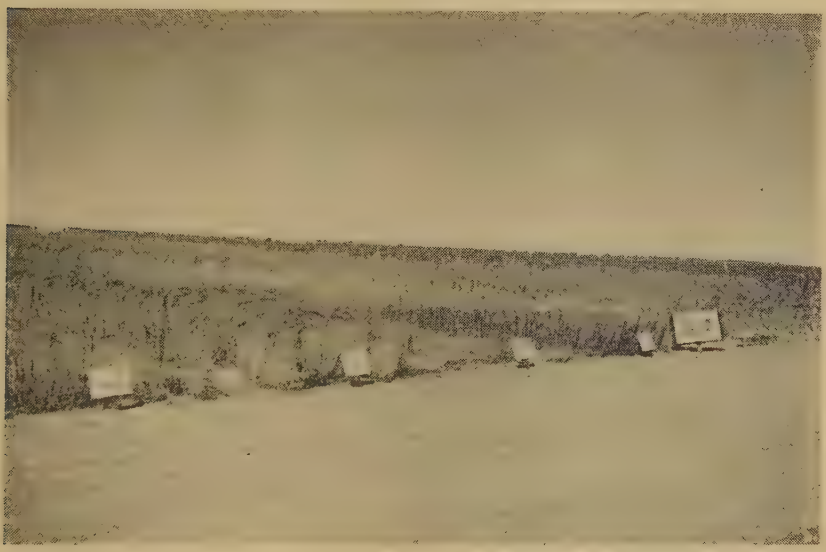
Marathon x Totadgin. M.75. This variety showed promise for grazing and recovery, but the grain yields were low.


MERREDIN
RESEARCH STATION
1946
Season.
M 80 (Eureka x Bungulla.)
Strength Figure, 10/4 Minutes
Consistency
Minutes
100
200
300
400
500
600
700
800
900
1000
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

Eureka x Bencubbin. M.77 and M.78. These early maturing varieties are being retained for further trial. At Merredin M.77 usually yields flour which approaches premium strength whilst M.78 is even stronger. Both have satisfactory straw strength and possess the Eureka type of rust resistance.

Eureka x Bungulla. M.79, M.80 and M.81. Of these M.80 will be retained for further trial, as in three of five tests it significantly outyielded Bungulla. The straw strength is very good for an early maturing variety and it usually yields flour of approaching premium strength.

Carrabin x Waratah. W.12. The yield obtained from this variety was not up to expectations.



The initial step in the production of pedigree seed is the maintenance of a "pure line," which serves to keep varieties breeding true for the varietal characteristics.

Varieties Tested Previously.

Bencubbin. Although this remains the most extensively grown variety in W.A., with 35% of the total acreage, in the drier districts many farmers are replacing it with Bungulla. Bencubbin remains the most prolific mid-season variety for the W.A. wheatbelt.

Bungulla. The late opening rains and dry spring conditions of the 1945 and 1946 seasons have served to emphasise the suitability of Bungulla for much of the W.A. wheatbelt. It is used extensively for planting ploughed up pasture land and was sown over 21% of the 1946 acreage, making it the second most popular variety in the State. Bungulla often tends to lodge if sown before the third or fourth week in May.

Eureka. The yields obtained from Eureka have been disappointing on the whole. It will probably be replaced at an early date by a variety such as Yalta, resistant to the new rust strain, to which Eureka and its derivatives are susceptible.

Kondut. This variety yielded well at Avondale during 1946, but in general the returns have been below those of Bencubbin. Kondut has strong straw and is recommended for first plantings on light land when the season opens early.

Koorda. This early maturing variety has yielded best on light soils where its strong straw is advantageous.

Charter. Bred by the New South Wales Dept. of Agriculture, Charter yielded relatively better in 1946 than in the previous year. It often produces flour of premium strength and the straw is fairly satisfactory. The maturity is early. Since it is resistant to the Eureka attacking strain of rust, Charter is recommended for planting in the very rust liable districts.

ACKNOWLEDGMENTS.

The authors would like to express their thanks to the staff of the Research Stations for their assistance in conducting the above trials:—

Avondale Research Station		Mr. W. A. Human.
Chapman	„ „	Mr. W. Coxon.
Merredin	„ „	Mr. F. Gishubl and E. Langfield.
Salmon Gums	„ „	Mr. J. Tudor.
Wongan Hills	„ „	Mr. D. R. Bateman.

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Codlin Moth in Western Australia.

By C. F. H. JENKINS, Government Entomologist.

Areas Affected.

IN March, 1947, when infested apples were discovered in a backyard orchard at Collie, was recorded the fourteenth outbreak of Codlin Moth in Western Australia. The pest has never become firmly established in this State but since 1903 fourteen separate outbreaks have occurred, which may be tabulated as follows:—

Albany	1903-1904	Collie (Most severe outbreak yet recorded)	1925-29
Perth, 4 outbreaks between 1904 and 1913		Narrogin	1926-27
Katanning	1913-14	Collie	1934-37
Bridgetown	1915-16	Mumballup	1937-39
Caversham	1918-19	Collie	1947
North Dandalup	1924-25		

With the exception of the Mumballup outbreak which is believed to have been an escape from the Collie area adjacent all infestations have undoubtedly been due to separate introductions from other States.

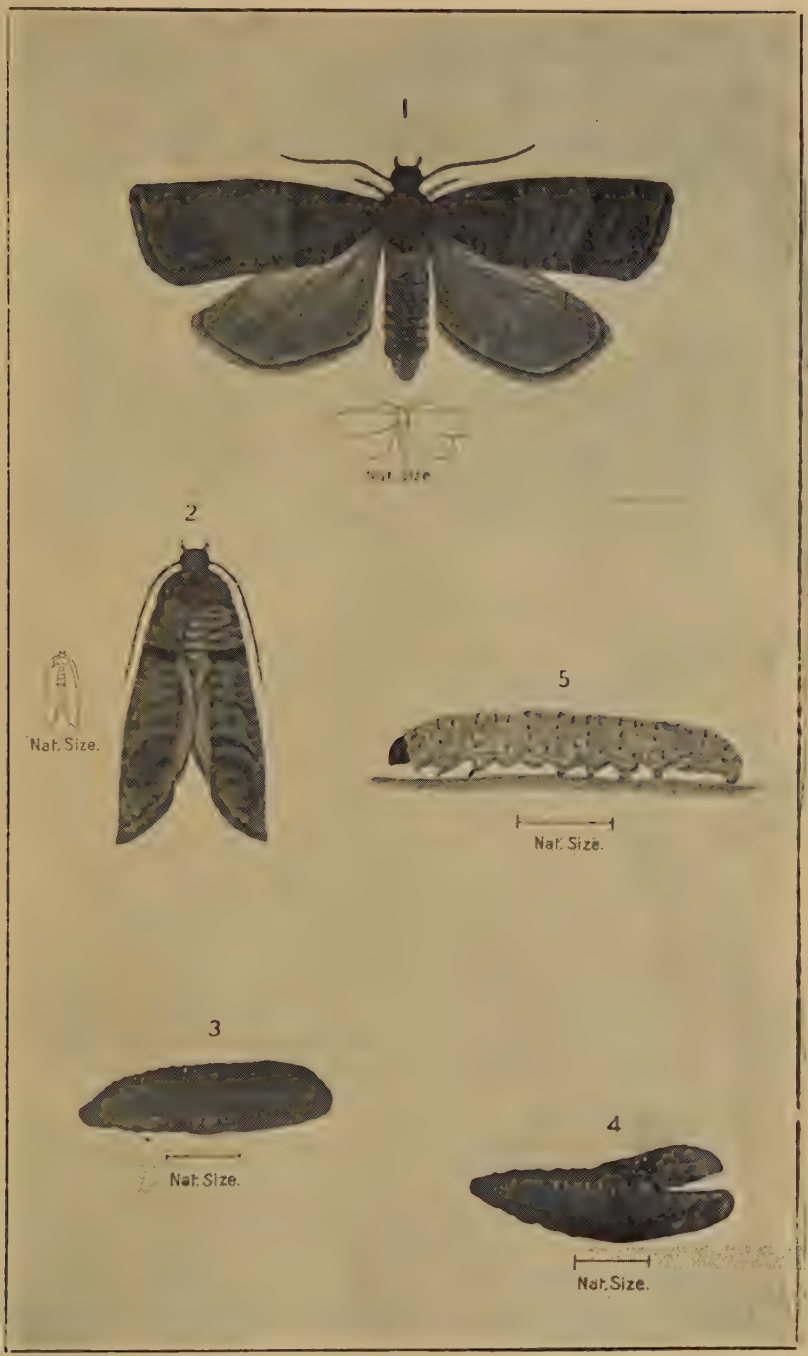


PLATE I.
The Codlin Moth.
Fig. 1—Moth with wings spread. Fig. 2—Moth at rest.
Fig. 3—Pupa. Fig. 4—Pupa case after moth has emerged.
Fig. 5—Caterpillar.

PLATE II.
Apples showing typical castings of Codlin lavae.

Suitability of Western Australia for Codlin Moth Establishment.

Western Australia is probably the only extensive apple growing area in the world in which the Codlin Moth is not established and strict quarantine regulations prohibiting the introduction of pome fruits (apples, pears, etc.) were early introduced to protect local fruit growers. The long list of outbreaks demonstrates that no system of quarantine is perfect and shows that constant vigilance is necessary on the part of growers. The fact that thirteen outbreaks have been successfully eradicated, however, has given rise to the belief in some quarters that this State is unsuitable for the establishment of the pest and it has been suggested that certain outbreaks have been recrudescences of earlier infestations. The severity of the first Collie outbreak clearly demonstrated the ability of the pest to thrive under local conditions and the fact that from 5 to 10 years have lapsed between the Collie outbreaks shows the impossibility of a pest such as Codlin Moth surviving unperceived during the intervening periods.

Methods of Introduction.

In no instance has the exact cause of any particular outbreak been traced but it is not difficult to suggest several means by which Codlin Moth could reach the State. During the recent war years, parcels forwarded from the Eastern States to troops stationed in Western Australia were found on several occasions to contain "Codlin" infested apples. With the improvement of air, rail and road transport the opportunity for ignorant or indifferent travellers to introduce infested fruits is ever increasing and is a constant menace. There are, however, other means by which "Codlin" caterpillars may enter the State. On leaving the fruit the caterpillars hide under any litter or bark to spin their silken cocoons and often choose a fruit or packing case for this purpose.

PLATE III.
Hibernating caterpillars of Codlin Moth taken from under bark during early winter.

Apples reaching Eastern States jam and sauce factories would contain a certain number of "Codlin" grubs and there is always the danger that some grubs may spin in packing cases or other merchandise to be later carried further afield. The fact that most local outbreaks have occurred either at ports or busy industrial centres supports this contention.

It may be asked why several outbreaks have occurred at Collie in comparatively recent years while none have been reported in Perth since 1913. This is easily explained by the fact that at one time, apple and pear trees were not uncommon within the city limits and Codlin Moths flying in the metropolitan area would have little difficulty in finding suitable food plants. This is not the case at present, however, whereas in the Collie area there is a profusion of fruit trees including apples and pears in almost every backyard offering every facility to caterpillars or moths transported in the district.

Co-operation Between Growers and Department of Agriculture.

The successful eradication of previous Codlin Moth outbreaks has been greatly furthered by growers drawing attention to the presence of the pest. The present outbreak may have gone for some time unperceived on account of its restricted nature had not specimens been forwarded to the Department by Mrs. Partridge of Forrest Street, Collie. The importance of forwarding for identification specimens of any strange insect causing damage cannot be over emphasised. If they are of no importance, no harm has been done, whereas if they are of a serious nature, the sooner they are detected the more likelihood there is of their being controlled.

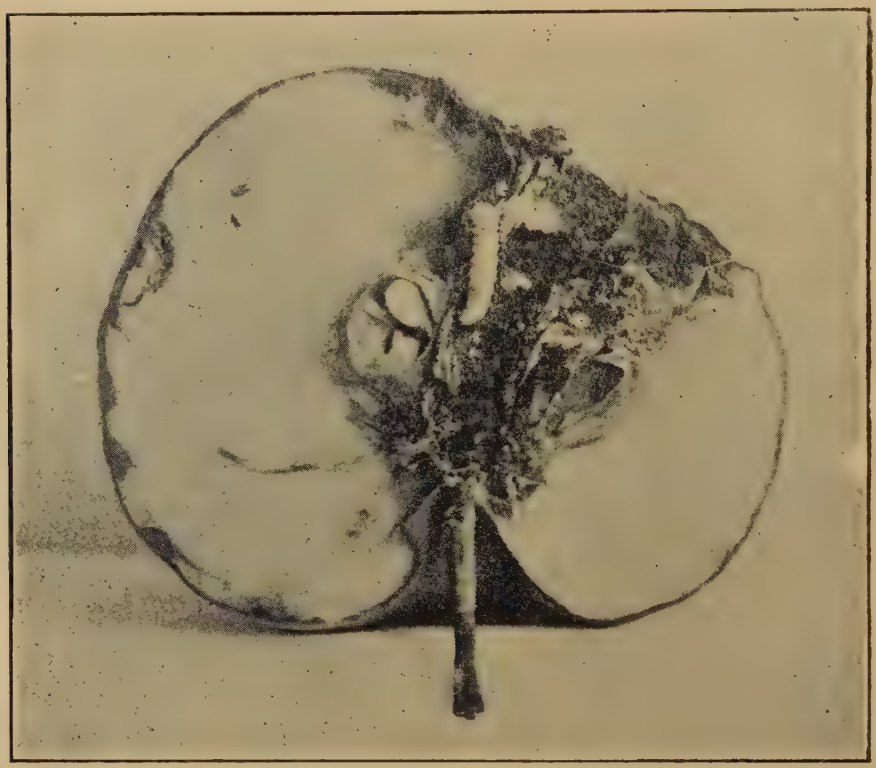


PLATE IV.
Cut apple showing typical work of caterpillars. (Note the pips have been consumed.)

How to Recognise Codlin Moth.

The illustrations accompanying this article will indicate the type of injury caused by the "Codlin" caterpillar. The "grub" is pinkish in colour and slightly under ¾in. in length. There are several other caterpillars with which it may be easily confused however, and growers are advised to immediately forward specimens to the Department of Agriculture should anything of a suspicious nature be encountered.

Contagious Ophthalmia (Pinkeye) of Sheep.

C. R. TOOP, Assistant Chief Veterinary Surgeon.

CONTAGIOUS ophthalmia better known to the sheep owner as "pinkeye" is a common disease of sheep particularly during the summer months. It is known to occur in the majority of countries where sheep are kept and, in Australia, is prevalent throughout the sheep raising areas.

The disease is highly contagious and may spread rapidly through the flock. It is caused by a microbe known as *Rickettsia conjunctivae* which is always present in the discharge from the eyes of affected animals.

The infection is believed to be spread by the agency of flies and the fact that outbreaks of the disease occur principally during the summer months lends support to this view.

Eye of sheep affected by ophthalmia. The eyelashes are gummed together with discharge and the cornea is affected by opacity. (After Edgar.)

The symptoms shown by affected sheep consist of a watery discharge from the eyes accompanied by inflammation, reddening and swelling of the eyelids. In a smaller proportion of cases there is opacity and ulceration of the cornea (transparent portion of the eye) together with a discharge of pus and partial or complete blindness.

Although the disease is not considered to be of serious economic importance it may nevertheless become a troublesome condition amongst travelling sheep particularly in the pastoral areas, whilst in farmers' flocks loss of condition and, in some cases, mortality may occur through the inability of sheep affected by blindness to obtain food and water.

After recovery has occurred sheep may continue to harbour the organisms in their eyes for several months during which time they remain carriers of infection and, although apparently healthy, are able to transmit the disease to other animals with which they are in contact. Recovery from the disease, moreover, does not result in the development of a lasting immunity and, when this is lost, the sheep again becomes susceptible and may suffer a further attack upon exposure to infection.

The recurrent outbreaks of contagious ophthalmia which may take place in a self-contained flock may be explained by the presence of these carriers of infection, the relatively short duration of immunity following an attack of the disease, and the fact that each successive drop of lambs adds to the flock a large number of highly susceptible animals.

The treatment of mild cases of the disease is not advised. Cases of this type predominate in the average outbreak and may be expected to recover spontaneously within a fortnight of the onset of symptoms. The treatment of such cases has no influence upon the rapidity of recovery. Severe cases showing evidence of blindness, however, should be removed from the flock for treatment and transferred to a hospital paddock or shearing shed where shade is available and there is easy access to food and water. The daily application of a 10 per cent. solution of zinc sulphate as an eye lotion is recommended for the treatment of these cases.

No effective method of prevention is known. The practice that is sometimes adopted of treating the whole of the flock in order to check the spread of the disease cannot be recommended. On the contrary by bringing the sheep into closer contact with one another it may favour the spread of infection and, since eye lotions cannot be relied upon to remove the organisms from the eyes of infected sheep, it cannot serve a useful purpose. Better results will be obtained by leaving the flock undisturbed, removing severe cases for treatment as they occur.

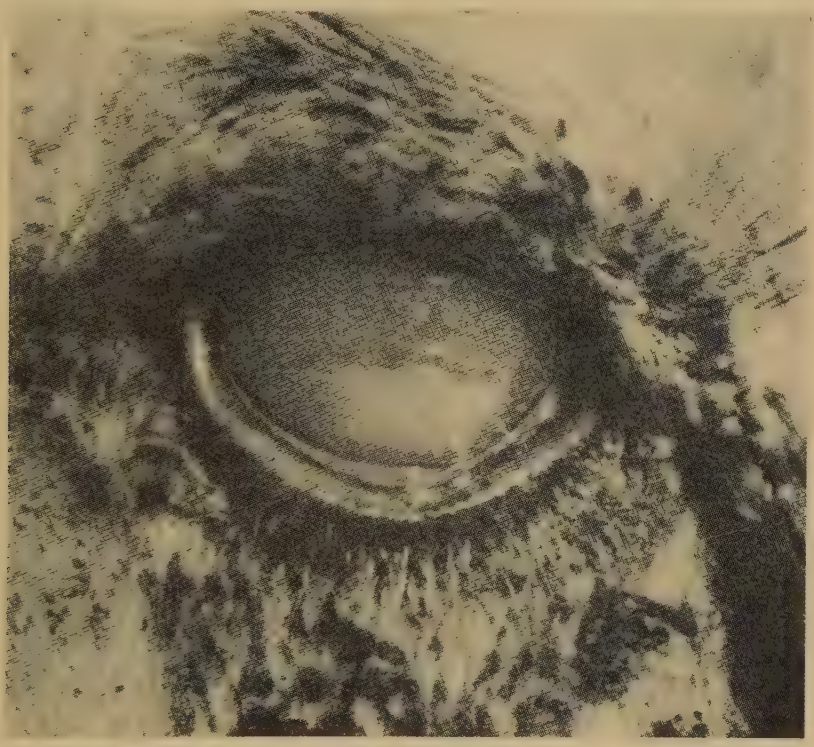
CAUSE.

The disease is caused by a microbe known as *Rickettsia conjunctivae*. These organisms are always present in the eye discharges of affected sheep and the disease may readily be transmitted from animal to animal when discharge taken from the eye of an affected sheep is placed in the eye of a healthy sheep.

Under field conditions the infection is believed to be spread by flies and the fact that the disease rarely occurs during the winter months and that outbreaks are frequent during summer and autumn when flies are prevalent supports this view. Moreover, when diseased and healthy sheep are held in adjacent pens in which direct contact cannot occur it has been observed that the disease has spread to the healthy animals, providing further evidence of the part played by flies in the transmission of infection. In the same manner infection may spread through fences from one property to another.

The infective agent does not survive very long apart from the sheep particularly upon drying of the eye discharges and it is, therefore, unlikely that sheep would become infected from trucks or yards previously occupied by diseased animals.

The view held by some sheep-owners that the disease is caused by dust or foreign bodies such as grass seeds is without foundation. It may also be mentioned that contagious ophthalmia of sheep is a highly specific disease which cannot be transmitted to other animals. The disease of cattle in which the symptoms are similar is caused by an entirely different type of organism.



A more advanced case. The cornea is opaque and ulcerated and there is an accumulation of dried discharge below the eye. (After Edgar.)

SYMPTOMS.

Sheep of all ages and breeds are susceptible to the disease. Both eyes invariably become affected but in some cases one eye may show evidence of infection a few days earlier than the other.

In the early stages of the disease there is inflammation and reddening of the conjunctivae (the membranes which line the eyelids and cover the front portion of the eyeball) with congestion of the blood vessels and swelling of the eyelids. This is accompanied by a profuse watery discharge from the eyes and discomfort upon exposure to bright light.

After a day or two the cornea (clear front portion of eye) commences to show evidence of opacity which first appears at the margin and may later extend towards the centre. The watery exudate is now replaced by a discharge

of pus which issues from the corner of the eye and gums the eyelashes together. The opacity of the cornea is usually only partial and though the sight may be impaired it is not seriously affected. In a smaller proportion of cases, however, the whole of the cornea becomes involved by opacity presenting a white milky appearance. The sheep in consequence becomes completely blind and unless given special attention may die through lack of feed and water. Ulceration of the cornea occurs in some of the more severe cases.

In the majority of sheep which become affected the disease occurs in a mild form, the opacity does not extend far beyond the margins of the cornea and complete recovery occurs within 10-14 days from the onset of the symptoms. In severe cases, however, the disease may persist for as long as six weeks and the animal may remain blind for a month during this period. It has been observed that the eye of the sheep has remarkable powers of recovery and that even when the cornea has become opaque and deeply ulcerated healing will occur leaving little or no blemish.

CARRIERS.

After the symptoms have subsided and recovery has occurred the casual organisms may persist in the eyes for several months. Investigations have shown that in about half of the sheep which have suffered from an attack of the disease the organisms are still present in the eyes 100 days after contracting the infection. One case in which a sheep remained infective for 250 days has been recorded.

Such sheep remain carriers of the disease and while showing no symptoms themselves they are able to transmit infection to other sheep with which they are in contact. The presence of these carriers will explain why recurrent outbreaks of the disease may take place in a closed or self-contained flock without the introduction of infected sheep from an outside source. Under such circumstances isolated cases may continue to occur in the flock passing unnoticed until conditions favouring the spread of infection such as droving or yarding for shearing or crutching during a period when flies are prevalent precipitate a severe outbreak. It also explains why sheep which are apparently healthy at the time of purchase may subsequently develop the disease.

IMMUNITY.

Recovery from the disease does not result in the development of a lasting immunity. Investigations have shown that recovered animals are resistant to re-infection for a period of about three months following upon which the immunity gradually wanes. More than 50 per cent. of recovered sheep, however, remain resistant for a year. When this resistance is lost the sheep again become susceptible and may suffer a further attack of the disease if exposed to infection.

When the relatively short duration of the immunity is considered together with the presence of carriers in the flock the periodical occurrence of fresh outbreaks of the disease will readily be understood. Moreover each fresh drop of lambs will result in the addition of a large number of highly susceptible animals to the flock thus increasing the chance of further outbreaks occurring.

TREATMENT.

Mild cases of the disease recover spontaneously and do not require treatment. This type of case predominates in the majority of outbreaks of contagious ophthalmia and observations have shown that recovery commences on the third or fourth day and is complete about seven days thereafter. It has been shown that the treatment of mild cases does not increase the rapidity of recovery. In experiments in which one eye was treated with 10 per cent. Zinc sulphate solution and the other left untreated as a control it was found that the untreated eye recovered just as rapidly as the treated one.

Severe cases showing opacity of the cornea, ulceration and blindness, however, require special attention, otherwise they may suffer serious loss of condition or death may result from starvation or thirst. Such sheep should be removed from the flock and transferred to a small hospital paddock where there is good shade and easy access to feed and water or, better still, they may be placed in the shearing shed where there is complete shade and hand-feeding may be practised.

For the treatment of these cases a 10 per cent. solution of Zinc sulphate is recommended, a few drops of which should be placed in the affected eyes daily until recovery has occurred. This lotion may be prepared by dissolving two ounces of Zinc sulphate crystals in a pint of water and may be applied with some convenient type of eye-dropper after separating the lids with the thumb and forefinger. A small oil-can will be found very useful for this purpose. Prior to treatment it may be necessary to clip the wool away from around the eyes and to remove any foreign bodies such as grass seeds, which may be present, with blunt forceps.

From the foregoing it will be obvious that there is no effective means of preventing the disease.

Since eye lotions cannot be relied upon to destroy the organisms which are present in the eyes of infected sheep, the practice which is sometimes adopted by sheep-owners of treating all members of the flock in an endeavour to check the spread of infection cannot be recommended. Indeed since this procedure by bringing the sheep into closer contact with one another favours the spread of infection it is likely to cause more harm than good.

It is far better to allow the flock to remain undisturbed making a daily inspection for the detection of badly affected or blind animals which should be transferred to a hospital paddock or the shearing shed for treatment.

Precautions should, however, be taken to prevent the introduction of the disease into a clean flock and a careful examination for the detection of ophthalmia should always be made whenever the purchase of additional sheep becomes necessary.

While the absence of symptoms does not necessarily indicate freedom from infection, since carriers may be present, a careful inspection prior to purchase may succeed in preventing the introduction of the disease into the flock and it is a precaution which should never be neglected.

Protein—From Where ?

L. C. SNOOK, Animal Nutrition Officer.

THE wide-spread lack of protein-rich foods is of considerable concern to those farmers who have to keep milch cows in production, feed laying hens, or raise pigs. The current shortage of linseed meal, oil-cake, meatmeal, and the various commercial products made therefrom, is likely to persist for some considerable time and farmers will have to adopt every possible expedient if their livestock are to continue in efficient production. It is no easy matter to suggest substitutes for foods such as linseed meal or meatmeal, as these are so excellent for their respective tasks, but a lack of a proven supplement does not necessarily mean that production must fall. In this article comments are made concerning a few protein-rich foods which may be turned to advantage until the happy day when the producer can again buy what he wishes to use.

Young Pasture.

Young pasture is the cheapest and the best source of protein available to farmers. It is not generally realised that young mixed herbage usually contains more digestible protein per unit dry weight than do most of the commercial food stuffs for which a high price is willingly paid. Good quality pastures may have a digestible protein content approaching that of linseed meal, the protein is of high nutritive value, and with this protein the animal also receives a liberal supply of minerals and essential vitamins. The value of young pasture was shown very clearly in Britain during the war years when the oilcakes and meals normally used were no longer available. Dairy herds were maintained in high production while receiving nothing but the grazing from well managed pasture. It was found that a few high producing cows could not eat enough of the bulky green grass to permit them to produce to their maximum, so a concentrated supplement had to be fed. But because the short herbage was so rich in protein, the supplement needed was a carbohydrate such as is obtained from cereal grain, and not a protein-rich meal as is usually fed in Australia.

It should be stressed that management is the most important factor influencing the quality of a pasture during the growing period. Grasses, as well as clovers, will yield protein-rich fodder so long as the growth is kept young by repeated grazing or mowing. For example, young rye grass or paspalum has a protein content equal to that of clover but with progressive growth the quality falls rapidly. It follows that farmers, dairy farmers in particular, can do much to make themselves independent of outside supplies of protein if they make maximum use of small paddocks grazed in rotation so as to keep the herbage in a young stage for as long as is possible. Remember that it is not essential to have the best quality pasture plants before benefit can be obtained from controlled grazing. Naturally the best results are obtained when the most suitable seed mixtures have been sown down but too much emphasis cannot be given to the fact that good management is a more important factor than the plants composing the pasture.

Greenstuff.

Poultry farmers are suffering more than most producers from the current shortage of protein-rich foodstuffs. Many cut greenstuffs for their birds and at the present time it may be profitable to cut this material much earlier than is the general practice. By doing so the total yield of herbage may be definitely decreased but the much higher protein content will more than compensate for this loss. In experiments with Phalaris grass, for example, plants which were cut five times during the growing season yielded less than half the dry matter obtained from plants which were only cut at maturity. But the total yield of protein was trebled by the frequent cutting, so that a protein-rich foodstuff containing 22 per cent. protein was obtained. Likewise, if lucerne is cut just before flowering it could be expected to contain about 25 per cent. protein in the dry matter whereas if left until after flowering the protein will doubtless have fallen to about 10 per cent. As protein is the constituent in most urgent requirement at the present time, it follows that it will pay to cut greenstuff as young as is practicable. In this regard it may be noted that lawn clippings generally contain considerably more digestible protein than do most of the laying mashes now on the market. So don't waste lawn clippings!

Hay.

Hay made from young herbage naturally contains much more digestible protein than does hay made from more mature material. Where protein-rich foods are required, as for feeding dairy cattle or lambing ewes, it may pay to cut crops for hay at an earlier stage than is usual. Here again it is necessary to draw a balance between yield and quality. By cutting earlier, the yield of dry matter will not be so great but a much richer fodder will be obtained. A word of caution is needed here, however. If crops are cut for hay too early in the season the drying material may be exposed to rain before it is cured. Rain quickly washes out the most valuable nutrients in hay so that the anticipated gains from early cutting will be completely lost if rain falls before harvesting is completed. Once again it is a matter of judgment (not to mention good luck!). The farmer himself must decide just how early he can cut hay without undue risk of loss in feed value due to rain.

The influence of time of cutting on quality and yield was well demonstrated by Underwood and Moir (1944) who showed that wheaten hay cut when the ears were half emerged yielded 123 lb. digestible protein per acre whereas other portions of the crop cut at the early dough stage yielded only 34 lb. A delay in cutting can therefore result in a very marked decrease in the amount of useful protein conserved; even to wait until a wheat crop has finished flowering will probably halve the yield of digestible protein. A similar loss occurs in meadow hay if this is not cut as soon as practicable. These figures show all too well that wherever stock are in need of protein, the hay reserves should be cut as early as possible.

Leguminous Seeds.

Leguminous seeds are well known as sources of good quality protein and in the form of field peas and lupins have been much used in this State. It is indeed a pity that the ravages of the pea weevil have greatly reduced the area sown down with field peas as these provide an excellent source of protein for cattle, sheep, pigs and poultry. As a matter of interest it may be noted

that if linseed meal costs £14 per short ton, field peas are worth something more than six shillings per bushel of 60 lb., considered as a source of protein (for fattening, peas have the same value as linseed meal).

Blue Lupins.

Lupin seeds are very rich in protein, containing about 35 per cent. in the dry matter, compared with the 24 per cent. found in field peas. The use of the blue lupin as sheep feed needs no comment here but it is suggested that the areas where lupins are so useful may perhaps be extended by trials with the New Zealand blue lupin which will grow in heavier, water-logged soils on which the local variety does not thrive.

Tangier Peas.

It is a matter of surprise that Tangier peas are not more commonly grown in this State as they produce a heavy crop of palatable nutritious greenstuff persisting well into the summer and the seeds, which are produced in great quantity, contain more protein than any other harvested in this State. Tangier pea seed grown at Wonnerup and Dwarda contained 39 and 40 per cent. protein respectively and if these seeds could be harvested for sale they should prove a very rich protein supplement. Some of the members of the Tangier pea family (*Lathyrus spp.*) bear seeds which contain a poisonous principle and although there is no record in this State of the Tangier pea seed ever causing any trouble it will be necessary to make certain that they are harmless before being used in large amounts. The Department of Agriculture plans to carry out the necessary experiments this season but meantime would appreciate any information which could be supplied by those who have fed Tangier peas in quantity to stock. It is hoped that this high quality seed can be turned to commercial advantage.

Cereal Grain.

Wheat or oat grain is generally accepted as an energy or fat producing food and is rarely considered as a source of protein. However, in view of the fact that cereal foodstuffs are used so extensively by poultry and pig farmers who are in such urgent need for increased protein supplies, it is worthwhile considering the relative value of cereal grains when grown in different areas, as cereals from the Eastern wheatbelt contains appreciably more protein than do similar grains grown nearer the coast. It has been shown (Snook, 1939) that wheat grown at Merredin may contain 15 per cent. protein in the dry matter (average of 5 years) as compared with only 9 per cent. in the same variety grown at Wongan Hills or Chapman. Likewise, oat grain grown at Nungarin may contain 15 per cent. protein as compared with the 8 to 9 per cent. found in the same varieties grown at Beverley. The difference in these values is quite considerable and may perhaps justify the purchase of grain from (say) Merredin, rather than from Northam, if the wheat or oats is to be fed to poultry or pigs.

Shrivelled grain, due to the lack of finishing rains, typically contains considerably more protein than does normal grain, so that screenings may be quite profitable buying to those seeking protein-rich foodstuffs. It may be mentioned,

incidently, that the high protein content of Merredin wheats is not due to shrivelling, as the grains containing high protein were characteristically plump and attractive.

SUMMARY.

Many farmers will require additional supplies of protein-rich foods during the coming season and the following sugestions are made.

1. Maximum use should be made of young pasture, which is the ideal food for grazing animals.

2. Greenstuffs for poultry or dairy cattle should be cut while young, as it then constitutes a protein-rich supplement.

3. Crops for hay should be cut at a younger stage than is usually practised, as the decrease in yield will be compensated by the considerably higher return of digestible protein.

4. Risk of exposure of hay to rain damage during curing should be avoided as much as is possible.

5. Leguminous seeds should be used wherever they can be grown or purchased at a reasonable price.

6. Where large amounts of cereal grains are being purchased for pig or poultry food, efforts should be made to obtain material from the Eastern Wheatbelt.

REFERENCES.

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Recent Trials with Selective Weed-killers.

G. R. W. MEADLY, Assistant Government Botanist.

IN recent years the use of selective chemical weed killers has been stimulated by encouraging experiences with substances not previously used for this purpose. Before discussing these highly complex, but at the same time most interesting compounds, it is proposed to trace briefly the discovery and development of chemicals as selective weed killers.

Firstly, to define the term selective weed-killer: This is applied to chemicals capable of killing weeds growing in crops, pastures or lawns, without causing permanent injury to the sown plants.

Most discoveries in agriculture and other sciences have been the outcome of planned research and this is largely true in the case of weed-killers. One of the early discoveries, however, was accidental. Just fifty years ago the first experimental work with copper sulphate was carried out, after weeds growing under fruit trees had been killed following spraying of the trees with copper sulphate to protect them from disease. Bonnet and other workers soon found that by spraying a growing cereal crop with dilute solutions of this and other chemicals it was possible to kill many annual weeds without seriously affecting the crop. Substances that gained some popularity for this purpose included iron sulphate, sodium sulphate and, as powders, Kainit and Cyanamide, but, because of its low cost and non-corrosive properties, copper sulphate was the most widely employed material for spraying cereals.

Sulphuric acid was found to give very effective results against a wide range of annual weeds and moreover, as it acted quickly, did not require a long period of fine weather following application. The major difficulty associated with the use of sulphuric acid was, and still is, its corrosive properties, although this has been overcome to a certain extent by the use of special lead-lined sprayers. Most of the early experimental work with this acid was carried out in France, where tens of thousands of acres of cereal crops were treated each season.

Despite the great value of sulphuric acid for weed control under European conditions and the advances made in the manufacture of spraying equipment, the need for extremely careful handling in the field by workmen still presented a disadvantage and the search for more suitable alternative substances continued. It was not until 1932, however, that any further appreciable advance was achieved. A patent was then filed in France for the employment of certain yellow dye stuffs for selective weed control in cereals and other crops. These substances were by-products of the distillation of coal and subsequently in France, and then in America, the sodium salt of one known to chemists as sodium dinitro-ortho-cresylate was placed on the market. It is now sold under a variety of trade names that are easier to remember, including dinoc in Australia and sinox in America.

The commercial preparation is a dense suspension of fine crystals forming a paste consisting of 30% of the cresylate and 70% water. If allowed to stand, a watery layer forms above a firm mass of the chemical, thus necessitating thorough mixing before use. Dinoc has the advantage that it is not corrosive either to clothing or metals but, being a dye stuff, stains skin and clothing. It is toxic if taken internally in comparatively large doses and poisoning may also result from continued inhalation of spray particles, but it is relatively non-poisonous when compared with the compounds of arsenic used for killing weeds.

Experimental work has shown that the addition of an acid salt such as sulphate of ammonia increases the effectiveness of the dinoc. Such activated solutions are more toxic to all plants and in consequence may prove less selective in their action. They have their greatest value when there is a comparatively large difference of tolerance between the crop and the associated weed community.

It is quite apparent from the results of detailed experimental work carried out in Western Australia as well as the Eastern States and other parts of the world, that conditions, especially relative to temperature and moisture, have a decided influence on the reaction of both weeds and crops to applications of dinoc. Local trials have been conducted on weeds in onions, flax, cereal crops and lawns and much of this work has already been recorded.*

Probably the most spectacular advance in selective weed-killers has been provided by various derivatives of phenoxyacetic acid. In 1940 workers, while investigating the effects of spraying "hormones" or growth promoting substances on cereals noted that one substance normally used to induce cuttings to root quickly, killed some of the annual weeds but not the cereals growing in the experimental pots. It was at once apparent that this substance possessed certain "Dr. Jekyll and Mr. Hyde" characteristics and a search was immediately instituted to find related compounds that would prove more active as selective weed-killers. By the end of 1942 two new materials had been selected as most promis-

*Dinoc—A Selective Weed-killer—G. R. W. Meadly, Journal of Agriculture, W.A. Vol. XXII No. 4, December 1945.

ing. Both are complex organic compounds and have in consequence long complicated names—2-methyl-4-chloro-phenoxy-acetic acid and 2:4 di-chloro-phenoxy-acetic acid. Fortunately more simple trade names have been given to proprietary lines of these substances, which are now being distributed under such names as methoxone, weedone and di-weed.

These "hormone" weed-killers are quite unlike other selective weed-killers. They act very slowly and their effectiveness is not dependent upon absorption through the leaves. This ability to cause slow destruction by root absorption means not only that the efficiency of the application is little affected by weather conditions but that any weed seeds of susceptible species that have germinated and are still below the surface may also be killed.

It is impossible to forecast with any degree of certainty the effect of dinoc or the "hormone" weed-killers on many types of weeds, and experiments have been undertaken to ascertain the relative efficiency of different products.

1. Double gee (*Emex australis*).

An experiment was commenced at the Merredin Research Station on 1st July to ascertain the effect of dinoc and methoxone on seedlings of double gee, one of the worst weeds of the agricultural and pastoral areas. The treatments consisted of—

(1) Control (unsprayed).
(2) 0.1% methoxone.
(3) 0.2% methoxone.
(4) 1.0% dinoc + 2 lbs. sulphate of ammonia per 100 gallons.

Each treatment was applied in the form of a fine spray to 1/300 acre plots replicated six times. The spraying, carried out in the morning, was followed by five points of rain on the day of application. A further 29 points was spread evenly over the remainder of the week. The soil is a clay loam and the double gees were in the young seedling stage, many not having developed more than cotyledonary leaves.

Three days after spraying a general withering and drying of the double gee leaves had occurred on the dinoc plots and only a very limited number of plants eventually recovered. Both methoxone treatments causing a yellowing of the plants and retarded their growth, besides inducing a more erect habit, but caused no marked difference in plant numbers compared with the controls. The effect of 0.2% methoxone was somewhat more conspicuous than the weaker solution. The following table shows means based on examinations made on 5th September, the figures representing surviving plants in five square link throws. Owing to the extreme effect, treatment 4 was omitted from the statistical analysis.

Treatment No.	Mean	Reconverted Mean
1	44	43.26
2	43	42.73
3	28	27.90
4	.05	

Difference necessary for significance of $\sqrt{x} = 0.901$ (1% level).

In all cases the data has been transformed in order that the analysis of variance could be validly applied. The symbol x has been used throughout as an abbreviation for the reconverted mean in connection with significant differences.

From the analysis of variance it has been shown that the means for treatments 1 and 2 are greater than for 3 so that 0.2% methoxone has given a significant reduction of double gee. The outstanding control, however, was achieved with 1% dinoc.

Besides the heavy infestation of double gees a quantity of Wimmera rye grass (*Lolium rigidum*), barley grass (*Hordeum murinum*) and canary grass (*Phalaris minor*) occurred on all plots. The spray applications did not result in any permanent injury to these plants which were flourishing when the counts were made in September.

The experimental work was followed by the treating of seedling double gees in the cereal test rows at the Research Station with 1.0% dinoc supplemented by 2 lbs. of sulphate of ammonia per 100 gallons of solution. Satisfactory results were obtained with applications as low as 100 gallons per acre.

The cost of materials and application prevent the use of dinoc for controlling double gees over extensive areas but it has saved much labour and expense with experimental plots which otherwise would have required hand weeding. Its use may prove convenient and practical for comparatively small areas of double gees, especially where they cannot be cultivated readily.

2. Capeweed (*Cryptostemma calendulaceum*).

An experiment with the same design as that described for double gee was carried out with capeweed on a sandy soil at the Wongan Hills Research Station. The chemicals were applied on 8th July when the capeweed varied from young seedlings to small plants, 2-3 inches across. The infestation was very dense with plants of few other species present. Six points of rain fell after the chemicals had been applied on 8th July and a further inch was recorded during the following four days.

Observations made on 26th July showed that the dinoc had given complete control of the capeweed but both methoxone treatments had only caused a slight tipping of the leaves. There was no subsequent recovery of the capeweed on the dinoc plots and the apparent effect of the methoxone did not increase. Quite effective results with seedling capeweed have been obtained with field trials in various parts of the State by using 100 gallons per acre of 1% dinoc containing 2 lbs. of sulphate of ammonia per 100 gallons of solution.

3. Rapistrum weed (*Rapistrum rugosum*).

A trial was conducted at Mingenew to ascertain the effects of a dinoc solution and different concentrations of methoxone on Rapistrum weed which is also referred to as turnip weed. The treatments were as follows:—

1. Methoxone—1 lb. per acre—100 gallons 0.1% solution. Applied at 2-4" rosette stage.
2. Methoxone—2 lbs. per acre—100 gallons 0.2% solution. Applied at 2-4" rosette stage.
3. Dinoc—1 gallon per acre—100 gallons 1.0% solution, plus 2 lbs. sulphate of ammonia per 100 gallons. Applied at 2-4" rosette stage.
4. Methoxone—1 lb. per acre—100 gallons 0.1% solution. Applied at commencement of flowering.
5. Methoxone—2 lbs. per acre—100 gallons 0.2% solution. Applied at commencement of flowering.
6. Control.

The six treatments were randomised within five blocks, individual plots being 1/100 acre. Treatments 1-3 were applied at midday on 3rd July. A light shower of rain followed the completion of the spraying. There was a satisfactory distribution of Rapistrum weed over the experimental area, the plants ranging from seedlings to small plants 3-4 inches across with six well developed leaves.

On August 13th weed counts were made on treatments 1, 2, 3 and 6, ten randomised one-square-link counts being made for each plot. Both concentrations of methoxone had given complete control of rapistrum weed without causing injury to the natural pasture consisting mainly of grasses. There appeared to be fewer rapistrum plants on the dinoc sprayed plots compared with the controls but the difference was not conspicuous. The plants were up to twelve inches across and some of the smaller ones had certainly appeared after the chemicals had been applied early in July. The methoxone undoubtedly affected seedlings which commenced development subsequent to the application of the chemical.

Treatments 4 and 5 were applied on 13th September when the more advanced plants had just commenced flowering. The day was fine and warm. Observations and counts made on these plots on 17th October revealed that methoxone had given a high degree of control with both concentrations and no seed formation had taken place. The results of this experiment are summarised in the following table, the numbers representing surviving plants per ten square link throws:—

Treatment No.	Mean	Reconverted Mean
1	0	.004
2	0	.004
3	7.0	6.15
4	0.4	0.32
5	0.4	0.27
6	16.2	15.34

Difference necessary for significance of $\sqrt{x + \frac{1}{2}} = 1.16$ (1% level).

The analysis of variance showed that the mean for treatment 6 was greater than for 3 which in turn was greater than for 1, 2, 4 and 5.

4. Flat weed (*Hypochoeris radicata and H. glabra*) and annual clovers (*Trifolium spp.*).

The species of *Hypochoeris* are two of the most troublesome lawn weeds in Western Australia and cause concern to keepers of bowling greens, golf courses and tennis courts along with the home gardener. Being a perennial, *H. radicata* is more difficult to control but large plants of *H. glabra* leave bare depressions when they die in the early summer, an unsatisfactory condition for playing areas where an even surface is necessary.

Annual species of clover such as hop (*Trifolium procumbens*), suckling (*T. dubium*) and woolly (*T. tomentosum*) occur freely as winter weeds in lawns. They are encouraged by many home gardeners as they introduce a pleasing green to an otherwise drab lawn in the winter but on playing surfaces such as bowling greens, golf greens and tennis courts clovers are a decided disadvantage.

Two experiments were designed to ascertain the relative value of various concentrations of dinoc and "hormone" weed-killers when applied to lawns containing flat weed and clovers.

Experiment 1.—The initial treatments were as follows:—

1. Methoxone 0.1%, 100 gallons per acre.
2. Methoxone 0.2%, 100 gallons per acre.
3. Methoxone 0.4%, 100 gallons per acre.
4. Dinoc 1% + 2lbs. sulphate of ammonia per 100 gallons, 100 gallons per acre.
5. Dinoc 1% + 2 lbs. sulphate of ammonia per 100 gallons, 400 gallons per acre.
6. Dinoc 1% + 10 lbs. sulphate of ammonia per 100 gallons, 100 gallons per acre.
7. Dinoc 1% + 10 lbs. sulphate of ammonia per 100 gallons, 400 gallons per acre.
8. Control.

One month after spraying. The two conspicuous plots free from clover are treatments 5 and 7. A control plot with a dense growth of annual clovers is partly shown on the left, while the foreground is untreated beyond the experimental area.

The plots were randomised in three blocks, each plot consisting of 1/400 acre. The treatments were applied between noon and 2 p.m. on 6th August. Light showers fell during the afternoon with a total of 11 points for the day. The falls for the subsequent four days were 17, 10, 34 and 133 points. The weed infestation was heavy, the flat weeds being up to three inches across and the clovers of comparable size while the couch grass (*Cynodon dactylon*) was in a dormant condition.

Observations made on the 28th August showed that treatments 5 and 7 had proved very effective against the annual clovers causing a complete drying from which no recovery had been made. The flat weeds, although dried to the same extent, already showed an appreciable amount of regrowth. The corresponding

lower rates of application of dinoc represented by treatments 4 and 6 were less effective but indicated that 1% dinoc with 2 lbs. of sulphate of ammonia per 100 gallons would give satisfactory control of clover at an application rate of 200 gallons per acre. This was confirmed by subsequent applications to playing areas. The cost of such treatment amounts to 4/- for materials sufficient to spray a tennis court and its proximity. The increased ammonia content caused no apparent improvement. The clover on the 0.1% methoxone plots was slightly browned and the growth was somewhat suppressed compared with the controls. The 0.2% and 0.4% plots showed proportionately greater browning and growth suppression. Although there was little alteration in the colour of the flat weeds some growth abnormalities were apparent on all plots.

By 4th September the flat weed was again vigorous on all dinoc plots, but the clover had shown no regrowth on treatments 5 and 7 and little recovery on 4 and 6. It was also noted that the 400 gallons per acre dinoc plots contained little silver grass (*Vulpia spp.*) which was present in quantity on all other plots.

The clover on the methoxone plots had further deteriorated compared with the controls. Many flat weed plants were dry and shrivelled while others showed abnormal twisting and vertical disposition of the leaves.

On the 16th October, half of each plot was sprayed with 0.4% methoxone at the rate of 100 gallons per acre. This meant that methoxone was superimposed on all previous treatments and half of each control plot received its first application. The day was cloudy but fine. It soon became apparent that the double application of 0.4% methoxone represented the most effective combination of treatments for controlling the flat weed. The following table includes figures for surviving plants in ten square links, (b) representing the half plot sprayed with 0.4% methoxone on 16th October. The figures for (b) did not lend themselves readily to statistical treatment and were therefore excluded from the analysis of variance.

Treatment No.	Mean	Reconverted Mean
1 (a)	74.7	74.13
(b)	6.0	
2 (a)	43.3	42.66
(b)	3.0	
3 (a)	16.3	14.45
(b)	0.7	
4 (a)	112.0	104.7
(b)	9.7	
5 (a)	54.0	52.48
(b)	3.3	
6 (a)	68.7	51.29
(b)	5.3	
7 (a)	72.0	69.18
(b)	18.0	
8 (a)	83.3	
(b)	14.7	

Difference necessary for significance of Log x = 0.410 (5% level).

Analysis of the figures showed that the mean for treatment 3 was less than all other treatments, which did not reveal significant differences *inter se*.

An indication of the cost can be gleaned by the fact that sufficient methoxone for two applications to a tennis court of a 0.4% solution at the rate of 100 gallons per acre is £1.

Experiment 2.—This experiment was designed to compare the effects of two proprietary "hormone" weed-killers, methoxone and di-weed on flat weed. The site was again a weed infested couch lawn at South Perth and the treatments were as follows:—

1. 0.2% methoxone—100 gallons per acre.
2. 0.4% methoxone—100 gallons per acre.
3. 0.2% 2-4 di-weed—100 gallons per acre.
4. 0.4% 2-4 di-weed—100 gallons per acre.

1/400 acre plots were randomised in five blocks and the solutions were applied on 19th November, a fine warm day. Counts were made on 17th January when it was apparent that the di-weed had proved more effective than the methoxone at equal concentrations. Practically 100% control had been obtained with the 0.4% di-weed as shown by the following table listing the number of surviving plants per ten square links:—

Treatment No.	Mean	Reconverted Mean
1	26	23.0
2	9	8.9
3	8	8.2
4	0.4	0.32
5	125	124

Difference necessary for significance log $(x + 1) = 0.312$ (1% level).

The analysis of variance showed that the means for all treatments with the exception of 2 and 3 differed significantly from each other.

At no time during the course of these two experiments was the couch grass obviously affected by the chemicals.

Besides the detailed experimental work which has been described, exploratory trials have been conducted with methoxone on blackberry (*Rubus fruticosus*), St. John's wort (*Hypericum perforatum var angustifolium*), Berkheya thistle (*Berkheya rigida*) and water hyacinth (*Eichornia crassipes*). The results with water hyacinth were sufficiently encouraging to warrant further experimental work but the chemical had little effect on the other species.

CONCLUSIONS.

Although members of the Cruciferae (cabbage family) can be regarded as a group susceptible to "hormone" weed killers it is difficult to anticipate the effect of the various "selective" chemicals on different species.

Dinoc was found eminently satisfactory for the control of annual clovers, capeweed and seedling double gees, while the phenoxy-acetic acid derivatives (methoxone and 2-4 di-weed) were less effective against these species but gave much better results when applied to Rapistrum weed and flat weed.

With Rapistrum weed, methoxone caused a high degree of mortality when applied at all stages of growth up to flowering. The "hormones" gave better results with flat weed when applied in the spring and summer than during the winter. This is probably associated with the more active growth linked with the higher temperatures.

Capeweed and annual clovers become more resistant to dinoc as the plants increase in size but can be largely controlled at the later stages of growth by increasing the concentration and rate of application. The same cannot be said of double gees which must be treated when in the young seedling stage before typical leaves have been formed.

The cost of materials restricts large scale use of these chemicals in Western Australia, but they have considerable value for local infestations of susceptible plants. Their use as selective weed-killers for playing areas such as golf links, tennis courts and bowling greens is sure to increase.

At the concentrations employed the hormones had no adverse effect on couch grass (*Cynodon dactylon*) or any of the naturalised grasses. Dinoc, especially with the higher rates and concentrations caused some tipping of couch grass and ce eals, but recovery was comparatively rapid. The bent grasses (*Agrostis spp.*) including brown top are more likely to be permanently affected, especially when sulphate of ammonia has been used as an activator. Dinoc should be used with extreme care on such swards.

ACKNOWLEDGMENT.

My thanks are due to fellow officers of the Department of Agriculture for assistance in carrying out the experiments described: also to Timbrol Ltd., Imperial Chemical Industries Ltd., and the Nightingale Supply Co. Ltd., who provided the dinoc, methoxone and 2-4 di-weed used in these experiments.

A Simple Method of Handling Feed Wheat in Bulk.

W. M. NUNN, Agricultural Adviser.

NOW that wheat for stock feed purposes is supplied in minimum 10-ton bulk truck loads, it has become necessary for farmers to make special arrangements for receiving wheat in bulk and for storing it in bulk on the farm.

Bulk handling and storing of feed grains has many advantages over bags. In the long run it is much more economical. Not only is the cost of the bag saved, but handling costs are minimised and so also are losses from mice, rats and weevils.

On properties in the Wheat Belt, where the conservation of feed reserves in the form of cereal grain has become a familiar practice, quite a number of bulk storage installations are to be found, varying of course, from elaborately constructed bins, to improvised structures of a temporary nature, according to the farmer's requirements.

Methods of filling the bulk container also vary. In some cases an elevator is justified, and in others steeply rising ground enables the bin to be loaded at one side and emptied at the other. In the majority of cases however, a great deal of handling is necessary in lifting bags to a staging and then tipping them into the bin.

Now that poultry farmers and pig raisers must accept wheat in bulk, a greater number of people are interested in ways and means of simplifying the handling and storing of bulk grains, and the following description is given of a

bin and hoisting gear which is giving satisfactory service on the property of Mr. H. E. Braine, at Chittering. Mr. Braine is manager of the Wheat Pool of W.A. and through the Pool will be happy to assist others with advice and material to enable them to construct a similar outfit.

The bin consists of a tank of corrugated galvanised iron. The grain is transported from the siding either in a bulk container on the buyer's motor truck, or in open mouthed or loosely tied stacks, and is shovelled from the container or tipped from the bags into a wheat bucket which is then hoisted by means of a simple winch and wooden gallows, for emptying into the bin.

The equipment necessary for this installation is:—

A 3,000 gallon galvanised corrugated iron tank, 24-gauge with 22-gauge bottom and waterproof cone top. The tank should have two sliding doors fitted opposite each other near the bottom and the top should have a 2-ft. diameter manhole or opening to receive the wheat.

View of the bin and hoisting gear in operation on the property of Mr. H. E. Braine, at Chittering.

Another view of the bin and hoisting gear in operation on the property of Mr. H. E. Braine, of Chittering.

A galvanised corrugated iron stand of 24-gauge iron, two sheets high. (Alternatively this could be made from wood on the farm.) If the iron ring stand is used, it is some inches greater in circumference than the tank bottom. The ring is filled with sand and the space between tank bottom and outside edge of ring is cemented.

A hoisting frame or gallows. This could be made of 4 x 4 jarrah uprights with a 4 x 4 cross piece or could be constructed from bush pole timber available on the farm.

A wheat bucket, winch, sheave wheels, rope and fittings.

Such an installation would cost only about £30 which is approximately equal to what would be the cost of purchasing and filling 250 cornsacks if they were obtainable at present nominal prices. However, new cornsacks are not obtainable, and the price, when they are, should be very much higher.

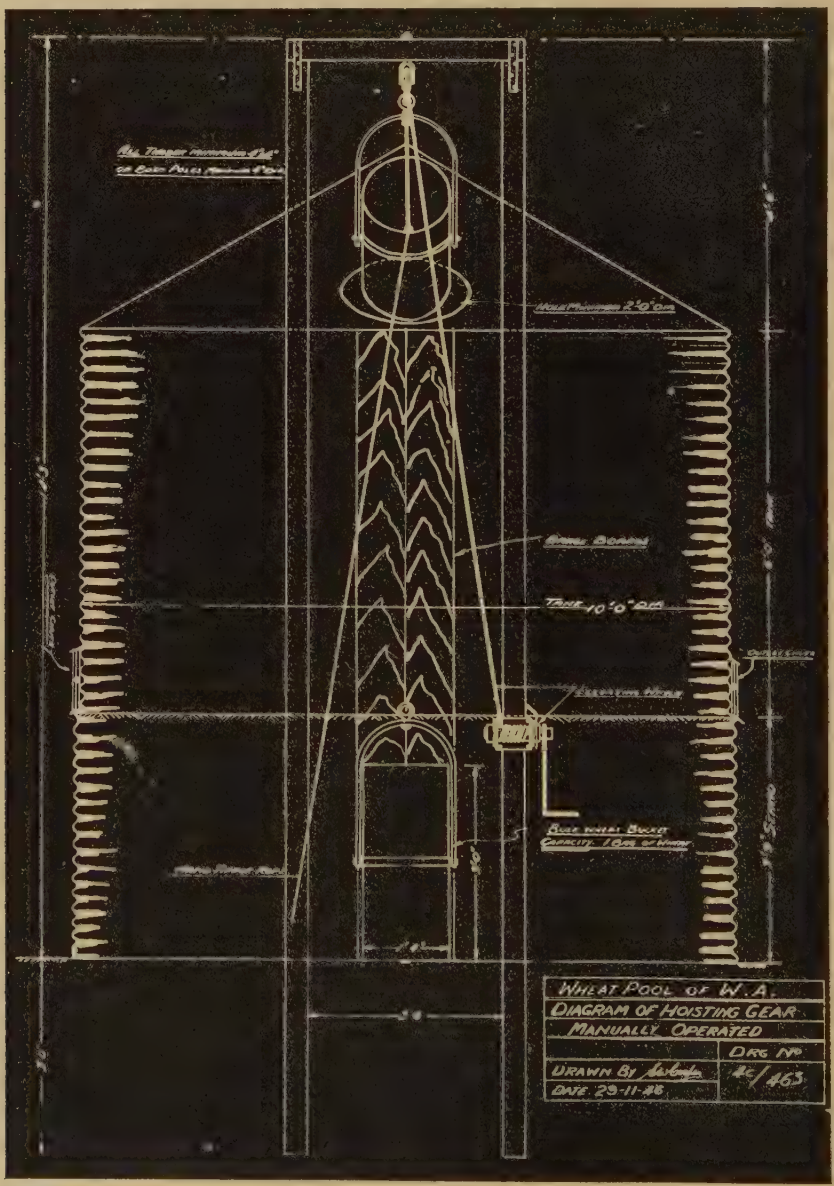
The present approximate cost of equipment would be:—

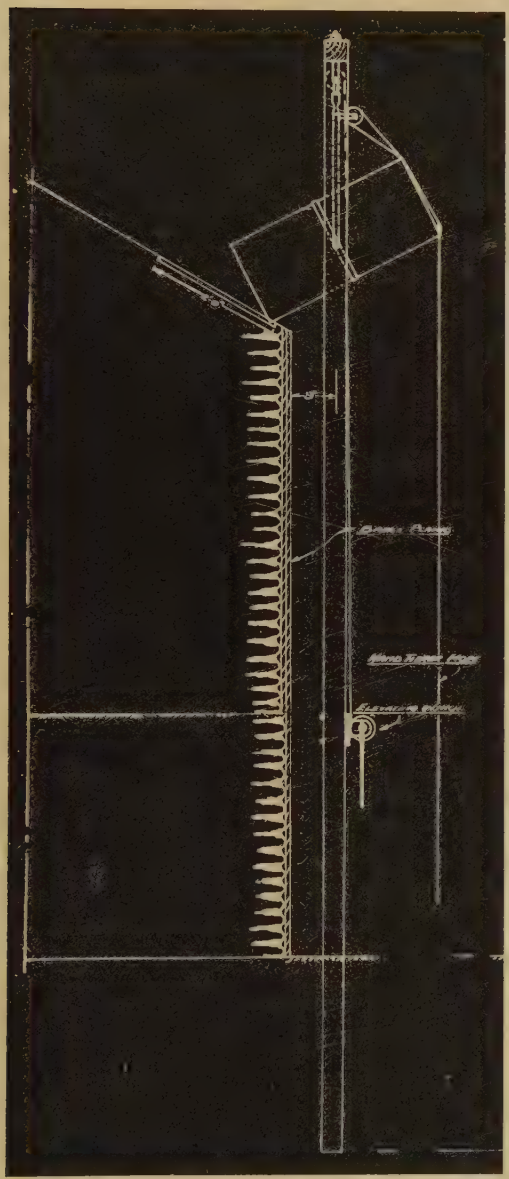
Tank	£18	Perth or Fremantle.
Stand	£1	„ „
Timber Gallows	£1	
Hoisting Gear	£6	

The Trustees of the Wheat Pool have advised that they will supply the hoisting gear consisting of wheat bucket, winch, sheave wheels, rope and fittings at the actual cost when material is supplied.

This outfit would have a capacity of 10-tons, and would be most suitable for use by poultry farmers and pig raisers who now obtain their wheat in 10-ton bulk trucks.

Diagrams prepared by the Trustees of the Wheat Pool, showing details of construction, are reproduced below.





Advisory Service In The Wheatbelt.

I. THOMAS, Superintendent of Wheat Farming.

Mr. G. L. Throssell addressing farmers at the Chapman Research Station, Field Day, 1946.

FARMING is not only a basic part of the nation's economy, providing raw materials for vital human requirements, but it is also the way of life for many people. Its appeal to the individual, as a means of livelihood, is naturally related in no small measure to the important feeling of being engaged in an interesting and absorbing occupation, with a high level of technical efficiency.

There is an evolutionary sequence in the development of every farm and most properties are now entering the most complex stage calling for the adoption of efficient practices in respect to crop rotations, the exact use of fertilisers, the use of high quality animals, and the best strains of pasture and crop species to suit the locality and its soils.

In respect to livestock, sheep and pig numbers have increased markedly in the wheatbelt, and it is likely that an even greater proportion of the farm income will be derived in future from livestock. Most livestock owners will encounter from time to time, expensive losses sufficient to absorb the profit margin, unless adequate precautions are taken to prevent parasite infestations and disease epidemics.

During the dry summer months, supplementary feeding will be required whilst the lambing percentage is dependent on the level of feeding of the ewes during the last six weeks of pregnancy. These varied aspects of animal husbandry all require the application of the most recent developments in research. The link between the farmer and the research worker is the extension officer whose function it is to maintain contact with both. Often the results of research as published do not apply to local conditions, and to use the findings it is necessary usually, to convert them to a routine farm operation capable of being applied on

any holding. For this reason the Wheat Branch now has highly qualified advisers stationed at Geraldton, Beverley and Kellerberrin, who will be pleased to assist farmers and others in obtaining information on agricultural and allied subjects.

The officers stationed in the various districts can be contacted either by letter or telephone at the following locations:—

GERALDTON (Government Bldgs.), Mr. G. L. Throssell, B.Sc., (Agric.).

BEVERLEY (Court House.), Mr. A. J. T. Marshall, B.Sc., (Agric.).

MERREDIN, Mr. E. R. Watson, B.Sc, (Agric.).

KELLERBERRIN (Court House), Mr. E. R. Watson, B.Sc., (Agric.).

Leaf Spot Disease of Black Mulberry.*

W. P. CASS SMITH, Government Plant Pathologist.

R. STEWART†, Department of Botany, University of W.A.

UNTIL a few years ago the black mulberry (*Morus nigra*) was affected by only one troublesome disease in Western Australia, namely bacterial blight caused by *Bacillus mori*.

In April 1943 a fungal "leaf spot" disease was also recorded for the first time, which has since spread so rapidly that it now occurs in practically all areas of the State where mulberries are grown.

Compared with most other fruit trees here, mulberries are of little economic importance. According to the Government Statistician, only 190 bushels of mulberries valued at approximately £950 were marketed during the 1945-46 season.

However, they are easily grown, even on our poorer sandy soils, and in consequence have been planted in many home gardens and orchards, mainly as single trees, and are prized as a source of fresh fruit.

In both the 1945-46 and 1946-47 seasons, this "leaf spot" disease developed very seriously, superseding the bacterial blight in importance. As a result many requests were received for information regarding control measures.

*Partly prepared in condensed form from a thesis presented by Miss R. Stewart, B.Sc., to the Department of Botany, University of W.A., in February, 1947, in part fulfillment of the requirements of an Honours degree. The complete thesis entitled "Investigations on the "Leaf Spot" Disease of Black Mulberries caused by *Septogloeum mori* (Briosi and Cavara)," will probably be published subsequently in the Jour. Roy Soc. of W.A.

†First Class Honours Graduate who investigated this disease under the supervision of the senior author.

Symptoms and Effects.

The disease appears to be confined to the leaves, for no evidence of wood infection has yet been discovered, despite careful search. On the leaves the disease is generally first noticeable early in the growing season, in the form of small dark brown, or blackish spots (1-2 mm. in diameter), usually surrounded by a zone of light green or yellow tissue. Under favourable conditions the leaf spots gradually enlarge and the central portions become whitish in colour. As they enlarge numerous very small black dots or pustules develop on the surface of the lesions which become most obvious in the pale central portions.

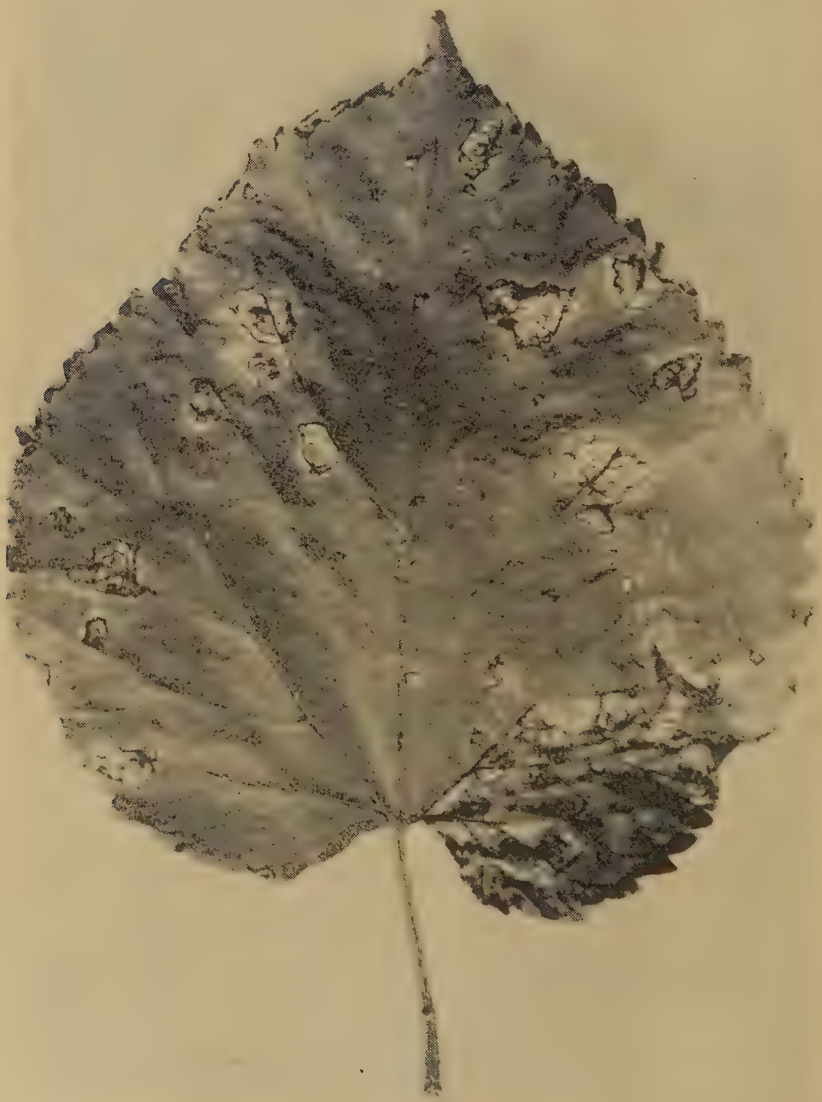


Fig 1.
Mulberry leaf showing "leaf-spot" symptoms due to the fungus *Septoglocum mori*.

In wet, humid weather, the pustules become upraised and distinctly pinkish in colour. These are the fruiting structures of the causal fungus which will be referred to later.

Enlargement of the leaf spots may continue until they are 10 mm. or more in diameter, when they typically appear more or less regular in outline, with dark brown margins and whitish centres. Infection also causes a browning of the veins in the vicinity of the necrotic area. The light green or yellowish areas which usually surround the spots vary considerably in extent. If the spots are close together, they coalesce as they enlarge, and when numerous or very large, extensive areas of leaf tissue wither and die. (Fig. 1). Leaves badly affected in this way soon fall from the tree.

When, as a result of the disease, severe defoliation occurs, the tree is weakened, and if this takes place early in the season, a reduced setting or a heavy premature drop of fruit is brought about.

Cause of the Disease.

Leaf spot of mulberries is caused by a fungus *Septogloeum mori* (Briosi and Cavara). If a thin transverse section is cut through a well developed leaf spot, and examined under the microscope, the minute black dots which were visible to the naked eye are seen to consist of structures similar to that shown in figure 2. These are the fruiting bodies (acervuli) of the causal fungus.

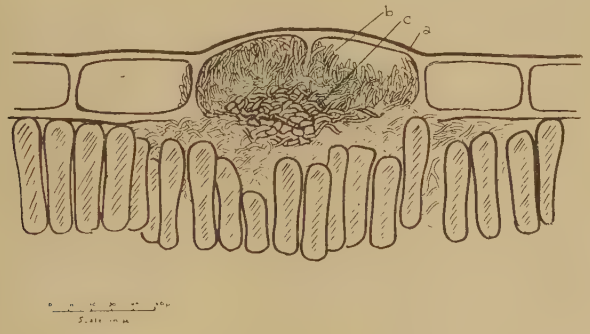


Fig. 2.
Transverse section of mulberry leaf, showing structure of fruiting body (acervulus) of *S. mori* (semi-diagrammatic).
a. Outer wall of upper epidermis of leaf. b. Spore mass.
c. Stromatic layer.

Essentially they consist of a flat plate (stroma) of dark, closely interwoven, fungal threads, from which arise numbers of short erect spore bearing branches (conidiophores). The fungal seeds or spores (conidia) which develop singly at the ends of the branches, are elongated in shape (length being approximately eight times width), thin walled and colourless, and divided usually by two or three cross walls.

The fruiting body or acervulus is formed beneath the epidermis of the leaf and during its development the epidermis is subjected to increasing stress. Finally when the fruiting body is mature the epidermis ruptures during wet, humid weather and the spores are exposed as a pinkish upraised mass (fig. 3).

The production of spores of this kind continues when conditions are favourable throughout the growing season of the tree, but in autumn when the vigour of the leaves is declining, spores of a different kind were found by Miss Stewart developing in the same fruiting bodies (fig 3 inset). These are thick walled, dark in colour, divided by from 1-9 cross walls, and in form somewhat resembling a string of beads.

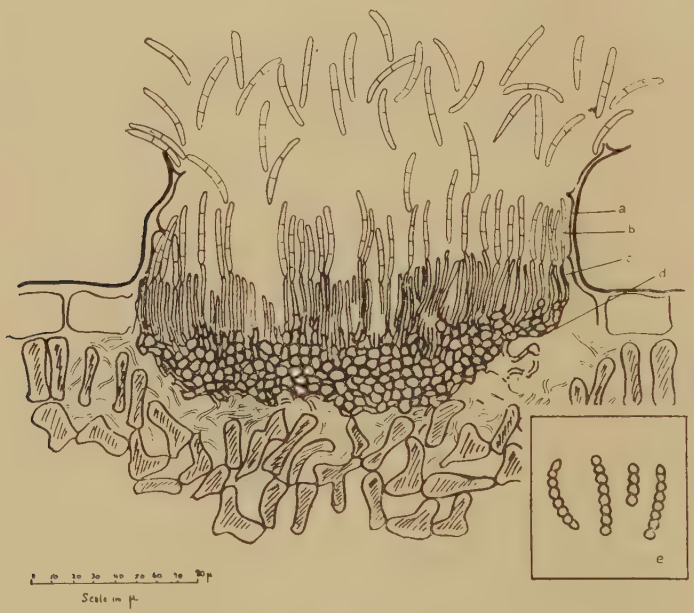


Fig. 3.

T. s. of fruiting body of *S. mori* at later stage than shown in fig. 2 (semi-diagrammatic). a. Ruptured outer wall of leaf epidermis. b. Thin walled spores (conidia) which serve to spread the disease during the growing season. c. Spore-bearing branches (conidiophores). d. Layer of interwoven fungal threads (stroma) from which the spore bearing branches arise. e (inset). Thick walled spores which develop in autumn, in the same fruiting bodies. Spores of this kind probably play an important part in the seasonal carry-over of the fungus.

Disease Development and Seasonal Carry-over.

After bud-burst in the spring, leaf spot symptoms of the disease usually first appear about a fortnight or so after heavy rains. In these infected areas fruiting bodies later develop, from which during wet weather are released the pinkish masses of thin walled spores. Spores of this kind serve to spread the disease rapidly during the growing season when conditions are favourable.

The spores are disseminated by wind and rain and some eventually lodge on other mulberry leaves. If hot dry weather prevails subsequently, however, most of these spores perish, but if conditions are cool and wet, the spores germinate in moisture and cause infection by sending out tiny infection threads which penetrate the leaves through the breathing pores (stomata) on the lower leaf surfaces.

From these infections other leaf spots develop, from which new spores arise, and this cycle continues while the weather conditions are favourable to the disease.

The last two seasons have been characterised by showery weather during late spring or early summer, conditions, which allowed the disease to reach epidemic form early in the growing season. As a result of the numerous leaf infections and severe early defoliation caused, the setting of fruit was reduced considerably in some cases, and in others a heavy premature drop of nearly mature fruit occurred.

With the advent of hot dry summer weather the disease becomes quiescent, but with the return to moist conditions in autumn it again becomes active.

The manner whereby the fungus is carried over from season to season is of great importance particularly in relation to control measures. Although extensive searches have been made, no evidence has yet been found of infected woody parts in which the fungus could persist during the winter months, neither has a sexual stage of the fungus been observed, either under natural conditions, or in artificial culture.

It seems unlikely that the thin walled spores which spread the disease during the growing season play any part in the seasonal carry-over of the fungus, except perhaps on rare occasions. They are quite unsuited to this purpose, as they germinate freely in moisture, and when dried infected leaf material is stored in the laboratory over the winter months, less than 1 per cent. of the spores remain viable. On the other hand, the thick walled spores which develop as the leaves are yellowing in autumn, appear to be ideally suited to the persistence of the fungus.

When naturally infected leaf material is held over winter, exposed to natural climatic conditions, more than 80 per cent. of these thick walled spores remain viable, and are capable of reproducing the disease, as shown in pathogenicity tests.

Aspects of this seasonal carry-over problem require further investigation, however, and it is hoped that these will shortly receive attention.

Control Measures.

Fortunately the disease has proved to be fairly easily controlled, even under conditions suited to epidemic development, by Bordeaux mixture or lime sulphur sprays, applied during the growing season.

Destruction of overwintering leaves would also appear to be a matter of importance from the control aspect, in view of the evidence which links them with the seasonal carry-over of the organism.

The following measures are therefore recommended to control the disease:

(1) At leaf fall in autumn rake up the fallen leaves, and destroy them either by burning or by burying them deeply in the ground.

(2) Just as the buds commence to swell in spring, spray the trees thoroughly with either lime sulphur 1:15 strength, or Bordeaux mixture 6:4:40 strength.

(3) About a fortnight later apply a second spray, either lime sulphur 1:50 strength, or Bordeaux mixture 3:4:40 strength.

(4) If subsequent to the second spray application, dry weather prevails, further sprays may be unnecessary. If wet weather prevails, however, further protection from the disease will be afforded by applying a third spray after the fruit is set, consisting of lime sulphur 1:100 strength or Bordeaux mixture 2:4:40 strength.

With each spray mentioned above, calcium caseinate at the rate of ½ - 1 lb. per 40 gallons should be incorporated as a spreader.

ACKNOWLEDGMENTS.

Grateful acknowledgement is made by the senior author for assistance received during the course of this investigation from collegues, Mr. H. L. Harvey and Miss O. Goss, of the Plant Pathology Branch, W.A. Department of Agriculture.

The authors also desire to thank the Superintendent of Horticulture, Mr. H. R. Powell, for enlisting the aid of certain members of his staff in reporting the distribution of the disease and collecting and submitting specimens. In the latter connection they particularly wish to thank Mr. E. H. Elkington.

Poultry Feeding Experiments Conducted at the Muresk Agricultural College with Laying Hens.

AN OUTLINE OF TRIALS NOW IN PROGRESS.

R. H. MORRIS, Agricultural Adviser.

POULTRY farmers have experienced considerable difficulty in obtaining desired supplies of mill offal with which to make up laying mashes for their hens. There is no indication that supplies of these materials will increase in the immediate future and experiments are now being carried out to test the value of poultry rations which contain minimum amounts of the relatively scarce foodstuffs.

A general view of the six sheds and 12 runs. Only three of the 12 shade covers over the water-troughs had been completed when this photograph was taken.

At the same time it would be interesting to ascertain the part which two of our most common grains, namely wheat and oats, can play in compounding rations for laying fowls.

Meatmeal is not as plentiful as we would like it to be and these above-mentioned combined facts have prompted the Agricultural Department to carry out a series of poultry feeding experiments, which are being conducted at the Muresk Agricultural College strictly on a practical basis.

The experiments have the following aims:—

1. To determine if whole wheat grain is an economical substitute for wheatmeal.
2. To determine if crushed oats can be used to replace mill offal.
3. To determine if crushed peas in conjunction with whole wheat and wheatmeal, can be used to replace mill offal.
4. To determine the economy of feeding whole wheat and whole wheat plus crushed oats combined with 10% meat meal.

The rations being fed on a weight basis are as follows:—

Group.	Bran.	Pollard.	Wheat Meal.	Meat Meal.	Crushed Peas.	Wheat.	Crushed Oats.
1	30	10	50	10	...	...	...
2	30	10	...	10	...	50	...
3	10	10	...	10	...	50	20
4	...	...	30	10	10	50	...
5	...	...	...	10	...	90	...
6	...	...	...	10	...	60	30

Rations 1-4 supply approximately 15% crude protein, which approaches the optimum level which can be attained by commercial producers with the foodstuffs now available. Rations 5 and 6 supply only about 14% crude protein but it was not considered advisable to increase the proportion of meatmeal above 10%

so long as supplies of animal protein are rationed. The various rations are mixed in quantity to ensure uniformity of quality and placed in twelve 44 gallon drums which have been converted into dry feed hoppers.

Field peas are not now available for feeding to poultry but where these can be grown at a reasonable cost they constitute an excellent protein-rich food for growing and laying hens. In an endeavour to obtain some index of the value of field peas to poultry a group receiving 10% crushed peas has been included.

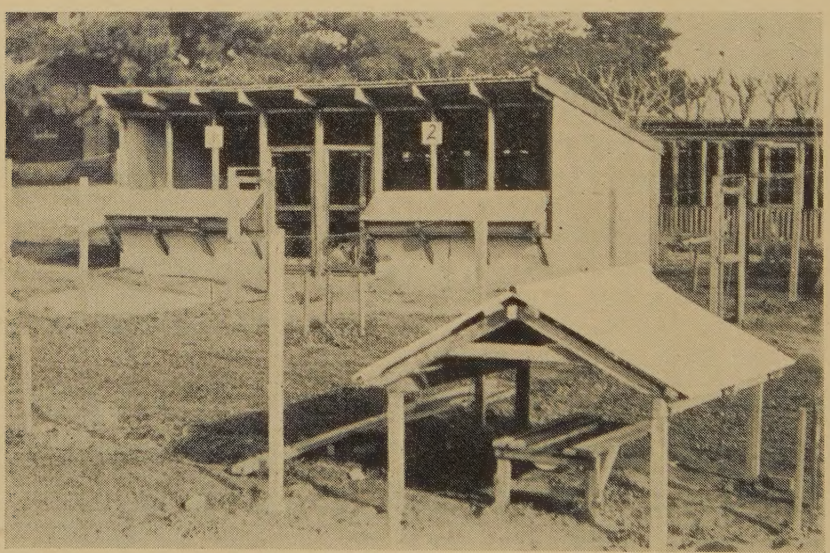
A mineral mixture consisting of five parts ground limestone and two parts bonemeal is available to the birds at all times. Common salt at the rate of 0.5% of the total ration is mixed in with the mashes or (in pens 5 and 6) mixed with the water used to dampen the whole grain prior to mixing in the meatmeal.

Each experimental group comprises 50 white leghorn pullets housed in odd numbered pens and 50 Australorp pullets housed in even numbered pens.

Each pen of fowls has access to its particular ration during the day from the dry feed hoppers. In addition a suitable quantity of these rations is fed as a wet mash to the respective pen each morning.

One half a kerosene tin full of finely cut greens is provided to all pens every evening and shell grit is always available.

The experiments are to extend over a period of twenty-four months from April 1st, 1947, to March 31st, 1949.

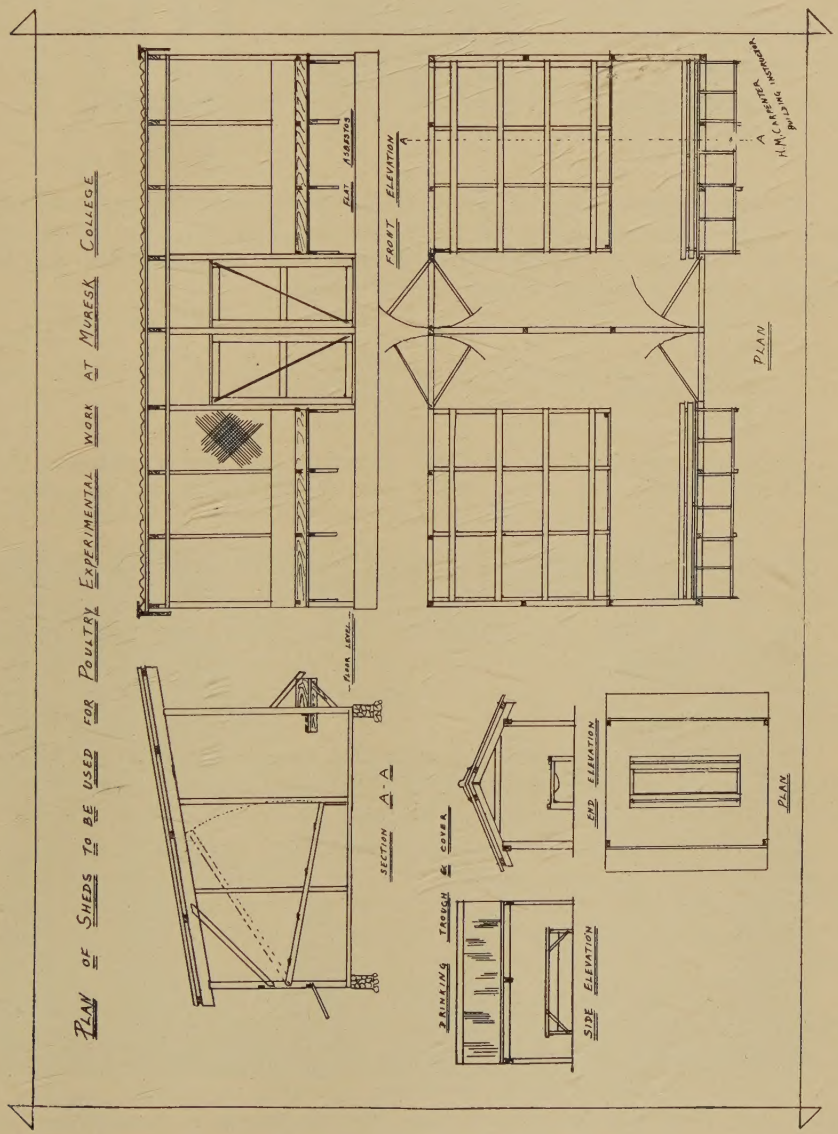


A close up of a shed with the watering system of Pen. No. 3 shown in the foreground. Each water trough is filled with a ball-cock and this type of watering system with accompanying shade covers has proved very successful during the summer just passed.

For the purpose three hundred Australorp and three hundred white leghorn pullets hatched in August-September, 1946, are semi-intensively housed in lots of fifty. The fowls in each pen have been selected as evenly as possible in regard to size, breeding quality and age and are appropriately leg banded.

The birds will be weighed at six monthly intervals and from time to time particulars of each pen, such as food consumed, number of first and second grade eggs laid and their value, (N.B. A first grade egg weighs two ounces or over) the profit over food cost, broodiness and the mortalities will be published in this Journal.

It is hoped that accompanying plans of the sheds and water troughs together with the photographs will give the reader a clear picture of the construction of these pens which house the experimental birds. The sheds are of corrugated asbestos, each shed being divided by a wire netting partition giving in all twelve houses which measures 12ft. x 12ft.



A plan of the sheds and water troughs.

Assistance to Importers of Pedigreed Stock.

FINANCIAL assistance on a substantial scale is now available to stock-breeders importing pedigreed stock from the United Kingdom, Canada or the United States.

A fund created by equal contributions from the State Government, the Commonwealth Government and the Commonwealth Bank provides for the payment of the following amounts in respect of approved stud stock:—

Cattle	£100 per head.
Draught Horses	£100 „
Pigs	£50 „
Sheep	£40 „
Milch Groats	£40 „
Poultry	£1 10 0 per head, or per setting of 16 eggs.

In addition to subsidy payments at the above rates, importers of cattle, sheep, milch goats and pigs from the United Kingdom will have the benefit of generous reductions in freight, shipping companies having agreed to carry approved stock at the following very low figures:—

Cattle	£50/8/- (Stg.) net per head.
Sheep	£16/16/- „ „ „ „
Milch Goats	£16/16/- „ „ „ „
Pigs	£13/13/- „ „ „ „

Stock-breeders who desire to avail themselves of the assistance offered should make application to the Department of Agriculture on the prescribed form which may be obtained direct from the Department or through a stock-broking firm. When the importation is approved advice is sent to the Commonwealth Veterinary Officer in London who issues a certificate to the shipping company concerned so that the reduced freight will be granted.

The importer must meet all costs in connection with the importation and should make application to the Department of Agriculture for payment of the subsidy after the animal has been safely landed and the provisions of the Quarantine Act complied with.

Payments will be made only in respect of animals for which a full certificate of registration by a recognised Stud Society is furnished together with the vendor's certificate of breeding and production record where applicable.

The scheme will also embrace importations by persons other than stock-breeders provided the stock imported is sold at an unreserved auction sale held within one month after the release of the animals from quarantine in Australia or within such extended time as may be approved by the Minister for Agriculture.

In this case the importer should make application for the intended importation to be included in the scheme, but the subsidy will be paid after auction to the stock-breeder who purchases for use in his own herd or flock.

A detailed statement of the conditions governing the scheme, together with application forms may be obtained from the Department of Agriculture, Perth.

By Authority: WILLIAM H. WYATT, Government Printer, Perth.